THE

JOURNAL OF MICROSCOPY

AND

NATURAL SCIENCE:

THE JOURNAL OF

THE POSTAL MICROSCOPICAL SOCIETY.

Editor:

ALFRED ALLEN,

Hon. Sec. P.M.S.;

WITH SEVERAL ASSOCIATE EDITORS.

VOL. VI. THIRD SERIES.

VOL. XV. OLD SERIES.

London:

BAILLIERE, TINDALL, & COX, 20 & 21 KING WILLIAM ST, STRAND.

Bristol:

JOHN WRIGHT & COMPANY, STONE BRIDGE.

1896.

BATH:

C. SEERS AND SON, PRINTERS, 2 ARGYLE ST.

Preface.

ACCORDING to our usual custom, we feel impelled to write a few words concerning the volume, which forms Vol. VI. of the Third Series of the *International Journal of Microscopy and Natural Science*, just finished.

The standard of excellence to which the Journal has attained during the last few years has, we believe, been well kept up in the present volume. As so many papers of scientific value have appeared in its pages, we hardly know which to mention without giving the whole list; but we must certainly point to the series of papers on "British Hydrachnidæ," by Mr. Chas. D. Soar, as being of the greatest service to those of our readers who are interested in this subject. Among other papers of interest we must mention our late President, Mr. Bryan's, account of Prof. Miall's researches on "The Origin of Insect Transformations," Mr. W. Falconer's article on "Some Adaptation of Water-Plants to their Environment," Messrs. Wager and Walker's paper "On the Structure of the Root," Miss Lily H. Huie's paper "On some Protein Crystalloids, etc.," Mr. C. D. Hardcastle's article on "The Origin and History of Varieties of Agate," etc. "On Limnæa Peregra," by Mr. W. Nelson; the continuation of Mr. H. C. A. Vine's memoir on the "Predacious and Parasitic Enemies of Aphides," etc.; Messrs. Hoole and Harrow's article on "Some Notes on the

Victoria Regia," must also be included in our list, besides many minor articles and abstracts from other scientific journals.

At the request of many members of the Postal Microscopical Society, we have published a number of Notes from the Society's Note-Books. From communications received, we are glad to hear that this has given great satisfaction to our readers. The Notes of Methods of Technique which we have given during the past year have also been much appreciated. We may also mention that the memoirs by Dr. Vicentini on the "Bacteria of the Sputa and Cryptogamic Flora of the Mouth" have been reprinted, and we hope to issue them shortly in book-form. Prof. W. D. Miller, of Berlin, has kindly written the preface to Dr. Vicentini's book.

We cannot conclude our remarks without expressing the hope that our readers will derive as much pleasure and profit from the present volume as they have from those which preceded it.

THE INTERNATIONAL

JOURNAL OF MICROSCOPY & NATURAL SCIENCE:

THE JOURNAL OF THE POSTAL MICROSCOPICAL SOCIETY.

"*Knowledge is not given us to keep, but to impart; its worth is lost in concealment.*"

[The Editor does not hold himself responsible for the views of the authors of the papers published.]

Presidential Address.

By R. H. Moore.

IN taking the Presidential Chair this evening, it is after a twelve months' dream as to why I was selected for it. My first tableau was a mild growl with my excellent friend, the Founder and Honorary Secretary of the Society, for recommending me to the position; however, his gentleness and courtesy soon dispersed my wrath. My second vista was one of perplexity and mental torture as to what I should say when I reached this chair. Official and municipal duties in my native city, "The Queen of the West," have prevented me for several years from actively prosecutiug microscopical studies. My third vision was a pleasant retrospect of twenty-two years' connection with a valuable Society and reflections of many hours of delight in writing in its books, preparing slides, and illustrating them, during the first half of its existence; whilst my fourth phantom was of a pleasant gathering now realised, when members, in great part unknown to each other, should meet for good cheer and to encourage our Honorary Secretary.

I have discovered nothing new in microscopical science, I am

not now in any way adding to scientific knowledge ; yet, I am as ready as ever to encourage a Society which fills an honoured place in microscopical researches.

On looking over the last published list of the members, I find that only six of us remain who united in starting the Society, and perhaps one of the reasons for which I occupy the chair to-night has been your desire to confer this great honour upon one who has never deserted it, and who has no inclination to do so.

The Value

of this Society has really never been questioned. We have had our critics through the twenty-two years of its history, some wise and some otherwise, but it holds the unique position of affording scientific instruction and recreation in the home. The wives, children, friends [and maidservants.—Ed.*], of some of our past and present members, have shared many pleasurable evenings through its agency in the enjoyment of microscopical pursuits. In scientific societies ladies and children are usually rigidly excluded, the husband and father must enjoy his scientific researches under Club rule. He is either missed or dismissed from the drawing-room to indulge in them. We possess the privilege of selecting our days and hours of study under the fascinating, although rather hackneyed term of "Home Rule." Our esteemed Honorary Secretary, in his address to you last year, referred to the utility of the Society in the inspiration it has given to its members to form local societies. True, we may have lost some members by this praiseworthy enterprise, but there is satisfaction in knowing that our work is carried on with no desire to merely benefit ourselves. If our roll of membership has been weakened, or some have not been added to it through the formation of local Societies, we have the compensation of a harvest of men and women who have been led into scientific studies from the seeds which have been scattered by our own institution. We possess the one great advantage of

* In one of our earlier note-books a member relates his experience somewhat as follows :—After an evening spent in examining one of our boxes, he left his microscope with the $\frac{1}{4}$-inch objective attached, and sundry slides on his study-table, and was much annoyed in the morning to find one of the slides smashed and the $\frac{1}{4}$-inch objective totally destroyed. On enquiry he learned that his maidservant had been doing her microscopy before breakfast !

cultivating scientific researches in the areas lying between towns and cities, where, through paucity of population, scientific societies cannot be maintained. We urge, therefore, the claims of the Society on the microscopists of our cities and towns, not so much for the sake of their own erudition, but we need their experience and help for the benefit of other students of the microscope who have less advantages, and to whom, if I may quote from a well-known advertisement, this Society comes "as a boon and a blessing to men." This great advantage can never materially lessen from the keen scientific competition of the age, because this Society supplements a want beyond its reach. Therein are the elements of growth and prosperity, and we strongly appeal to microscopists in our larger towns to co-operate with us in rendering the Society attractive and of distinguished value to those who may become members from the rural districts.

During the last few years we have lost members who were real workers in special subjects in the microscopical world. Their slides, and the note-books which accompanied them, were especially valuable. I am afraid, from what our Secretary tells me, that this loss is still going on. I would strongly urge on those who remain to us, and who are noted for excellent work, to continue that work for the benefit of those who, if less experienced, are not less ardent in their love of microscopical science, and who deserve every encouragement from the more experienced members.

The Work

of the Society has passed through many phases, and thanks to our enterprising Honorary Secretary, his fertile brain has often evolved new schemes for attracting scientific pursuits. Boxes of single miscellaneous slides have been supplemented by those of series slides, where members contribute the whole of the contents, and are able to write in and illustrate the note-books in a truly educational spirit. Sections have been formed especially for pathological and botanical study, and if they have not succeeded to the extent that was desired, the experiment was valuable in ascertaining the need or otherwise of such a particular branch of study. Since my selection to fill the chair to-night, I have been careful to note the quality of the contributions which have been circulated during the

past twelve months, and I am pleased to testify to their great value. One member, Mr. Bostock, has contributed valuable slides and information in regard to the *Oribatidæ*. Dr. Walker sent round some well-mounted, double-stained slides of stems, buds, and roots, which were well illustrated and described. He has also added to our information by a series of Odontophores. Mr. Neeve circulated a box of Marine Algæ, illustrated by dried and mounted specimens and notes; followed by a second series, with highly finished drawings from the pencil of Miss Phillips. Mr. Bassano has favoured the Society with botanical and entomological objects; Dr. Bossey, Mr. Dawson, and the Rev. A. C. Smith, have aided us by well-mounted specimens of Diatomaceæ. Messrs. Beardsmore, Fisher, and several others, have done excellent work in the botanical division of microscopical science.

In examining the slides and reading the notes of these and other members who have so usefully served the Society, I am painfully reminded of my own short-comings, and perhaps our Honorary Secretary is rejoicing that he has helped to place me in a position where I am compelled to act the part of a penitent. If there are any other members of this Society who share my feelings to-night, we had better atone for the past by a pious resolve here and now to alter our ways. I may add, however, that if, during the last few years, I have not been a worker, I assuredly have not been a critic of the contributions of my fellow members. You will not find in the note books any complaints of my own that boxes are not up to the average, slides are not well finished, and notes are sparse. I have profited by the remarks of our Secretary that those members who complain of few notes are usually those who never add any. In thinking over our Work, I believe the Honorary Secretary will be glad to receive, not only series slides, but boxes which contain slides of a series character confined to a particular plant or insect. While there may be nothing new in objects comprised in the three kingdoms of nature, their respective types having been so earnestly studied, there yet remains much of novelty to be disclosed by patient observation of particular parts of structure. I well remember in earlier years contributing boxes of slides and notes and drawings, which perhaps I may be permitted to describe as "monographs."

I was particularly interested in the microscopical details of what are called "common objects" lying all around us. The *Senecio vulgaris* (Groundsel), the *Linaria Cymbalaria* (Ivy-leaved Toad-flax), the *Anogallis arvensis* (Scarlet Pimpernel), afforded me hours and days of interesting study. I found no existing literature which described their microscopical details, and so I was obliged to examine them patiently and carefully before I could write about them. Had opportunity offered, I should have been delighted to pursue similar investigations, for I know of no more fascinating employment for needle, scalpel, and lens, than to prepare and chronicle the hidden beauties of the commonest objects which lie around us. That which I attempted in the field of Botany equally applies to the region of Entomology. If some of our members could be induced to take up such studies in the new year we enter upon to-night, I am confident that their "monographs" would be attractive and instructive, and that many of them will find their way into the pages of our Journal because of their real value. I would also suggest that Animal Parasites offer another field for excellent study, and that they will furnish slides and notes of attractive and instructive character. Since my contributions, as stated before, I was deeply interested in Parasites, as to the variety of form and of appendages, their limb structure so adapted to their habits, and especially as to their frequent rudimentary organs. I commenced a box of slides, with note book and drawings to illustrate a dozen specimens, but, alas!

"Art is long, and Time is fleeting."

They still lie in my study drawer, incompleted, and filling my heart every now and then with a fond regret. I shall, however, use my best endeavours in the coming winter to resume my studies, and employ some of its hours, if possible, in actively helping our Society. In speaking of work, I am sure it would be interesting to all of us if our members would search their own particular districts for microscopical objects. For example, in my own native city the Mineral Waters of Bath are the habitat of the Fresh Water Alga, *Oscillatoria tenuissima*, which, according to Harvey, is only to be found in those celebrated warm waters. Specimens and illustrations of such native subjects would, if circulated among our members, be instructive and beneficial to all.

Having sketched the value of the Work of our Society, let me dwell for a few moments on its

PROSPECTS,

and I see every reason for encouragement, and not one for despair. It is too true that we want more members to fill the places of those who have resigned, or who have been lost to us by death. It is also true that in our centres of industry many of our older Scientific Societies, in this competitive age, are languishing, if they have not already died out, but as I have before stated this Postal Microscopical Society holds a unique position. She is a fairy visitor to our homes. We never want to go abroad to find her. She interests our wives and children, and under our own lampshade and by our own fireside we can pursue our microscopical studies. Wonderfully convenient as well as valuable. For this reason we ought to be able to increase our membership year after year, and with good slides, full notes, and copious drawings, success will be assured. While we use every effort to retain our members who are in the midst of city and town life with all its advantages, we ought to make a special effort to secure new members from our rural districts, where men and women are engaged in microscopical pursuits under many disadvantages. May I venture to hint that a short but a striking occasional advertisement in one or more of our popular scientific and technical journals would be desirable? I do not now see the weekly *English Mechanic*, but a few years ago its pages were often enriched by excellent microscopical chapters, proving that a large portion of its readers must have been interested in Microscopy. If they are still continued, would not an occasional advertisement of our Society bring us some new working members?

Would it not be possible to circulate boxes with notes, at occasional intervals, confined to the subjects of dry, balsam, and fluid mounting of slides? How to prepare vegetable and animal tissues, so as to procure a better knowledge of histology. We might take advantage of the rapid progress of Technical Education. The classes now in full operation, under the management of our County Councils, will undoubtedly cultivate all branches of Science, and Microscopy will have its share of attractions among the artizans and middle classes of our land. My own experience is, that for

a long time past some of our best microscopical work has been achieved by men who hold aloof from our Societies on the ground that the Societies are too learned or too respectable. I believe that this Society can offer great advantages to an influx of students belonging to our Technical Schools, if its objects are better known. A question would probably arise as to a lower rate of subscription, and a membership with or without an obligation to subscribe to the Journal, but this part of the subject could be discussed and a scheme evolved by the enterprise of our Honorary Secretary. My one aim is to assist workers in microscopical studies. I have no desire to reduce the intellectual and scientific status of this Society, and to enrol anybody and everybody who chose to apply for admission. I cannot, however, close my eyes to the fact that students from our elementary schools are passing in large numbers to the science classes which have been formed, and their studies will create a demand for such a Society as our own.

In reference to our prospects, I am anxious that our heartiest support should be given to our Honorary Secretary in the enterprise he shows in connection with the *Postal Microscopical Journal.* It must be a very heavy tax on his time and resources. If we compare the recent volumes with those of earlier date, the growing excellence of the Journal is apparent to every one of us. Its high-class papers and elaborate illustrations deserve the support of all of us. If it were possible for him to impart only a small portion of his energy into the minds of his readers we should very soon obtain an extended list of subscribers.

I deeply regret that your President is one wholly unable to enrich you with the researches of an ardent student of Microscopical Science. He is far too respectful to his fellow members to indulge in a resumé of Microscopical researches, up to date, culled from the several Journals which are at their own command. He has been contented to review the past, study the present, and to offer a few words of encouragement and stimulus, so that the future of this Society may be prosperous and progressive.

Experimental Evolution amongst Plants.*

By L. H. Bailey.

DE VARIGNY has written a most suggestive book upon Experimental Evolution, in which he contends for the establishment of an institution where experiments can be definitely undertaken for the purpose of transforming a species into a new species. "In experimental transformism," he writes, "lies the only test which we can apply to the evolutionary theory. We must use all the methods we are acquainted with, and also those, yet unknown, which cannot fail to disclose themselves when we begin a thorough investigation of the matter, and do our utmost to bring about the transmutation of any species. We do not specially desire to transform any one species into another known at present; we wish to transform it into a new species. . . . Experimental transformism is what we need now, and therein lies the only method we can use."

This is a most commendable object, and I hope that the attempt will be made to create a new species before our very eyes. This is what most people demand as a proof of evolution, and they are sometimes impatient that it has not been done; and it would seem, upon the face of it, that nothing more could be desired. When I reflect, however, upon the fact that this very thing has occurred time and again with the horticulturist, and consider that botanists and philosophers persist in refusing to see it, I am constrained to offer some suggestions upon De Varigny's excellent ambition. If I show a botanist a horticultural type of recent or even contemporaneous origin, which I consider to be specifically distinct from its ancestors, he at once exclaims that it is not a species, but a horticultural variety. If I ask him why, he replies, "Because it is an artificial production!" If I show him that the type is just as distinct from the species from which it sprung as that species is from its related species, and that it reproduces its kind with just as much certainty, he still replies that, because it is a horticultural production, it cannot be a species.

* Abstract of an Address before the Massachusetts Horticultural Society, Boston, Feb. 23, 1895, in *The American Naturalist*.

In what, then, does an accidental horticultural origin differ from any other origin? Simply in the fact that one takes place under the eye of man, and the other occurs somewhere else! It is impossible, at the present day, to make a definition of a species which shall exclude many horticultural types, unless an arbitrary exception is made of them. The old definitions assumed that species are special creative acts, and the method of origin is therefore stated or implied in all of them. The definition itself, therefore, was essentially a statement of the impossibility of evolution. We have now revised our definitions so as to exclude the matter of origin, and thereby allow free course to evolution studies; and yet here is a great class of natural objects which is practically eliminated from our consideration because, unhappily, we know whence the forms came! Or, to state the case differently, these types cannot be accepted as proofs of the transformation of species because we know certainly that they are the result of transformation!

Now, just this state of things would be sure to occur if De Varigny were to transform one species into another. People would say that the new form is not really a species, because it is the result of cultivation, domestication, and definite breeding by man. He could never hope to secure more remarkable transformations than have occurred a thousand times in the garden; and his scheme—so far as it applies to plants—is essentially that followed by all good gardeners. Or, if the prejudices of critics respecting the so-called artificial production of species could be overcome, he could just as well draw his proofs of evolution from what has already been done with cultivated plants and domesticated animals, as from similar results which might arise in the future from his independent efforts. I am not arguing against the scheme to create a species before our eyes, but I am simply stating what has been and is the insurmountable difficulty in just this line of endeavour—the inability of the experimentor to satisfy some scientific men that he has really produced a species; for it is a singular thing that, whilst all biologists now agree in defining a species upon its tangible and present characters, many of them nevertheless act upon the old notion that a species must have its origin somewhere beyond the domain of exact history.

This notion that a species, to be a species, must have origi-

nated in nature's garden and not in man's, has been left over to us from the last generation—it is the inheritance of an acquired character. John Ray, towards the close of the seventeenth century, appears to have been the first to use the word species in its technical natural history sense, and the matter of origin was an important factor in his conception of what a species is. Linnæus' phrase is familiar: "We reckon as many species as there were forms created in the beginning." Darwin elaborated the new conception—that a species is simply a congregation of individuals which are more like each other than they are like any other congregation—and with a freedom from prejudice which is rarely attained even by his most devoted adherents, he declared that "one new variety raised by man will be a more important and interesting subject for study than one more species added to the infinitude of already recorded species. The old naturalists threw the origin of the species back beyond known causes; Darwin endeavoured to discover the "Origin of Species," and it is significant that he set out without giving any definition of what a species is. I have said this much for the purpose of showing that it is important, when we demand that a new species be created as a proof of evolution, that we are ourselves open to the conviction that the thing can be done.

I have said that no modern naturalist would define a species in such terms that some horticultural types could be excluded, even if he desired that they should be omitted. Haeckel's excellent definition admits many of them. In his view, the word species "serves as the common designation of all individual animals or plants, which are equal in all essential matters of form, and are only distinguished by quite subordinate characters." It is impossible, however, to actually determine, if one has a species in hand, by applying a definition. One must show that his new type—if it is a plant—has botanical characters as well marked as similar accepted species have; and these characters must show, as a whole, a general tendency towards permanency when the plant is normally propagated by seeds. He must measure his type by the rule of accepted botanical practice. If the same plant were found wild, so that all prejudice might be removed, would the botanist unhesitatingly describe it as a new species? If yes,

then we should say that a new species had been created under the hand of man; and this rule I wish now to apply to a very few familiar plants. In doing so, I do not wish to be understood as saying that I consider it advisable to describe these plants as species under the existing methods of botanical description and nomenclature, for, merely as a matter of convenience and perspicuity, I do not; but I wish to show that they really are, in every essential character, just as much species as very many other universally accepted species are.

[The speaker then produced numerous instances of the evolution of forms of garden plants, in various genera, which are as distinct from their parents, and from each other, as accepted species of the same genus are; and these forms are as permanent, when multiplied extensively through many years by means of the seeds, as these wild species are. "Here we have absolutely new and unique types, as De Varigny demands, and they are as distinct from each other and from their parents, in accepted botanical characters, as 'good species' in the same genus are from each other, and they perpetuate these characters as unequivocally as those species do. Moreover, we know definitely what their origins were, and they therefore answer all the purposes of experimental evolution.

"All this is but another illustration of how tenaciously botanists still hold to the Linnæan idea of species, whilst they profess the Darwinian idea."]

I have now brought to your attention a few familiar plants for the purpose of showing that what are, to all intents and purposes, good species have originated in recent years; and that, whilst Botanists demand that the origination of species within historic times shall constitute the only indisputable proof of organic evolution, they nevertheless refuse to accept as species those forms which have thus originated, and which answer every demand of their definitions and practice. The proofs of the evolution of species, drawn from the accepted practice of the best botanists themselves, could be indefinitely extended. We need only recall the botanical confusion in which most cultivated plants now lie, to find abundant proof of the evolution of hundreds of types so distinct that the best botanists have considered them to be species;

but other botanists, basing their estimate of species upon origins, have reduced them or reincluded them into the form or type first described. Consider the number of species which have been made in the genus Citrus, comprising the various oranges, lemons, limes, and the like. Recall the roses. The moss-rose and others would be regarded as distinct species by any botanist if they were found wild, and if they held their characters as tenaciously as they do under cultivation. In fact, the moss-rose was long regarded as a good species, and it was only when its origin began to be understood that this opinion was given up. The earlier botanists, who were less critical about origins than the present botanists are, made species largely upon apparent features of plants, although their fundamental conception of a species was one which was created, as we find it, in the beginning. Yet, strangely enough, we at the present day profess to regard species as nothing more than loose and conventional aggregations of similar individuals, and which we conceive to have sprung from a common ancestor at some more or less late epoch in the world's history,—we make our species upon premises which we deny, by giving greater weight to obscurity of origin than we do to similarities of individuals.

The fact is that much of the practice of systematic or descriptive botany is at variance with the teachings of evolution. Every naturalist now knows that nature does not set out to make species. She makes a multitude of forms which we, merely for purposes of convenience in classifying our knowledge of them, combine into more or less marked aggregations, to which we have given the name species. Now and then we find in nature an aggregation of successive individuals, which is so well marked and set off from its associated groups, that we think nature to have made an out-and-out distinct species; but a closer acquaintance with such species shows that in many cases, the intermediate or outlying forms have been lost, and that the type which we now know is the remainder in a continuous problem of subtraction. In other cases, it appears to have arisen, without intermediate forms, as a distinct offshoot from an older type. This is well illustrated in many remarkably distinct garden forms, which originated all at once with characters new to the species or even to the genus. I have mentioned such a case

in the Upright tomato. Even the sudden appearance of these strange forms is proof that species may originate at any time, and that it can be no part of our fundamental conception of a species that it shall have originated in some remote epoch. Species-making forever enforces the idea of the distinctness and immutability of organic forms, but study of organisms themselves forever enforces an opposite conception. The intermediate and variable forms are perplexities to one who attempts to describe species as so many entities which have distinct and personal attributes. So the garden has always been the bugbear of the botanist. Even our lamented Asa Gray declared that the modern garden roses are "too much mixed by crossing and changed by variation to be subjects of botanical study." He meant to say that the roses are too much modified to allow of species-making. The despair of systematic botanists is the proof of evolution!

I repeat that mere species-making, in the old or conventional sense, is an incubus to the study of nature. One who now describes a species should feel that he is simply describing a variable and plastic group of individuals for mere convenience' sake. He should not attempt to draw the boundary lines hard and fast, nor should he be annoyed if he is obliged to modify his description every year. This loose group may contain some forms which seem to be aberrant to the idea which he has in mind; and it would seem as if he should be ready to call them new or distinct species whenever, from whatever cause, they become so much modified that it is convenient, for purposes of identification and description, to separate them from the general type. Just as soon as botanists come to feel that all so-called species of plants are transitory and artificial groups maintained for convenience in the study of nature, they will not ask whether they are modified outside the garden or inside it, but will consider groups of equal distinctness and permanence to be of equal value in the classification of knowledge, wholly aside from the mere place of their origin. At the present time, the garden fence is the only distinction between many accepted species and many discarded ones. The cultivation of man differs from the methods of nature only in degree, not in kind; and if man secures results sooner than nature does, it is only another and indubitable proof of the evolution of

organic forms. It is certainly a wholly unscientific attitude to demand that forms originating by one of nature's methods are species, while similar forms originating by another method are beneath notice.

If species are not original entities in nature, then it is useless to quarrel over the origination of them by experiment. All we want to know, as a proof of evolution, is whether plants and animals can become profoundly modified under different conditions, and if these modifications tend to persist. Every man before me knows, as a matter of common observation and practice, that this is true of plants. He knows that varieties with the most marked features are passing before him like a moving panorama. He knows that nearly every plant, which has been long cultivated, has become so profoundly and irrevocably modified that people are disputing as to what wild species it came from. Consider that we cannot certainly identify the original species of the apple, peach, plum, cherry, orange, lemon, wine grape, sweet potato, Indian corn, melon, bean, pumpkin, wheat, tobacco, chrysanthemum, and nearly or quite a hundred other common cultivated plants. It is immaterial whether they are called species or varieties. They are new forms. Some of them are so distinct that they have been regarded as belonging to distinct genera. Here is the experiment to prove that evolution is true, worked out upon a scale and with a definiteness of detail which the boldest experimenter could not hope to attain, were he to live a thousand years. The Horticulturist is the only man in the world whose distinct business and profession is evolution. He, of all other men, has the experimental proof that species come and go.

It is stated that Prof. Carl Barus has constructed a new top for educational purposes. The "peg" of the top consists of a writing stylus, adapted to pencil a graphite record of its motions upon a slate or sheet of paper. The motion of the "peg" simulates the motion of procession about a moving axis, which, in its turn, is in both rotational and translational motion. The complex spiral and cycloidal curves which may be thus obtained present an exceedingly beautiful appearance.

The Fixation of Nerve Fibres by Formalin.*

By Edwin M. Kitchell, M.D.

WITH the exception of osmic acid, the older fixatives do not preserve without considerable shrinkage of the axis cylinder of the nerve fibre; therefore, as formalin has, in my hands, given excellent results in the preservation of the axis cylinder, and as its effects on the myelin are also rather interesting, I have thought that it might be useful to publish a note on the subject.

The tissues used in my experiments were pieces of the sciatic nerves of the dog and of the rabbit, cut through their entire thickness. Even with pieces of tissue of this size, formalin penetrates and fixes the fibres throughout the nerve. I used one, two, ten, twenty-five, fifty, and a hundred per cent. of the commercial solution.†

In the specimens treated with one and two per cent. formalin, the axis cylinder and myelin were both shrunken, as they would be by alcohol, for example. Ten per cent. causes less shrinkage than two per cent, but is still unsatisfactory. In the specimens fixed in twenty-five, fifty, and a hundred per cent., the axis cylinder remains entirely or almost unbroken in the majority of the fibres. The results were rather better with formalin of full strength. The diameter of the unshrunken axis cylinders, under these circumstances, is about 0·5 to 0·8 of that of the entire fibre.

I tried staining the nerve fibres fixed in formalin with acid fuchsine, eosine, and other aniline dyes; also Gage's hæmatoxylin, (over-staining). All these colour the connective tissue strongly while the unshrunken axis cylinder is but lightly stained. I thought Gage's hæmatoxylin rather the best. Axis cylinders, on the other hand, which are considerably shrunken, are readily stained by these dyes. This may, perhaps, be explained by the concentration of the material taking the stain in a smaller space, which is the case when the axis cylinder is shrunken.

Transverse sections of the fibres in twenty-five to one hundred

* From *The New York Medical Journal*, July 20th, 1895.

† This is a forty per cent. aqueous solution of formaldehyde.

per cent. formalin solution show numerous little lines which run through the myelin in an irregularly radial direction. When viewed longitudinally, the appearance is that of a fine network, the so-called neurokeratin network.

This network is much more distinct and regular than that seen in the myelin of nerve fibres, which, for example, are fixed in Müller's fluid. It is well shown by staining with Weigert's hæmatoxylin, or with iron-alum hæmatoxylin. By either of these methods the network is stained black, while the spaces between the meshes are colourless and appear empty.

When stained by either of these methods, the fibres, as seen in cross section, are of a somewhat different appearance from that already described, for, instead of the lines running through the myelin, black bands are seen with white spaces between them.

Osmic acid stains the network (of the formalin hardened substance) a faint brown.

The appearance of nerve fibres hardened in formalin is the same whether teased, stained, or mounted in glycerin, without the use of alcohol, or soaked in alcohol and ether, as for celloidin embedding.

When nerve fibres (also tissues from the central nervous system) are stained by Weigert's method after formalin fixation, the reducing fluid should be diluted from five to ten times with water, otherwise the decoloration will be too rapid and uneven.

From the results above described it would appear that formalin is a valuable addition to the list of reagents for the fixation of nerve fibres.

The Cebus and the Matches.—Prof. E. D. Cope, writing to the *American Naturalist*, says :—" A *Cebus apella* in the Philadelphia Zoological Garden has become an expert in striking matches. He distinguishes the end with the fulminate, and I have not seen him make an error in this point. He seizes the match at the proper distance from the fulminate and so avoids breakage. He uses for friction the rough side of a kettle which is used for water, and spends no time on the glazed surface. As soon as the match is lit he throws it away, and I have not seen him burn himself. No man could handle the match more appropriately. He does not, however, always select a proper surface, as he tried on one occasion to strike a match on my finger without success."

Louis Pasteur.

By H. W. Conn. From *Science* (U.S.A.).

NEVER has the world been called upon to lament the death of one whose life was so full of gifts to humanity as that of Louis Pasteur. Others have lived with equal genius, others there have been whose influence upon thought has been equal or greater. Others have attained an equal reputation from achievements of various kinds; but no other man in the history of the world has given to mankind so many valuable gifts as those which have come from the labours of Pasteur. That Pasteur possessed great genius is manifest, but yet it was not wholly genius that explains his marked preëminence, for a certain modicum must be attributed to the timeliness of his work. His greatness was due in a measure to the fact, that early in life he had the fortune to have presented to his attention, and the wisdom to seize upon great problems for solution. He early seized for his own an almost new field of research, and brought to this new field an equipment entirely different from that which any other scientist had possessed. Pasteur is regarded as the father of modern bacteriology, but we must remember that he was not a pioneer in these lines of work. There was hardly a problem that he studied which had not been already recognised, and even studied to a greater or less extent by his predecessors; but at the same time there was not a single problem which Pasteur undertook to solve which was not when he undertook it in a most crude, unsatisfactory condition, and when he left it, in its almost perfect form. It was in reaping fruits where others failed, and in perfecting the work which had been begun by less competent scientists, that Pasteur's merit lies. Others discovered facts, Pasteur determined laws.

In looking over the life of Pasteur as a whole, we are struck forcibly with two characteristics. The first was its almost uniform success. Doubtless Pasteur occasionally failed in his experimental work. But of this the world has known nothing, for his conclusions seem to have been always correct. So far as Pasteur has appeared before the public from the beginning to the end of

his career he has enjoyed an uninterrupted success. The French people have slowly learned to recognise this, and finally acquired such a confidence in him that it has been a popular saying which has met all criticisms that "*Pasteur never makes mistakes.*" This unique testimony of public confidence is unexampled, but it seems to have been well deserved, for certainly no scientist has ever held such a position before the public and made so few mistakes. This is the more remarkable when we remember that he was working in an almost unexplored field. The reason for this uniform success lies primarily doubtless in the nature of the man; but not a little of it we may attribute to the fact that in his early training Pasteur was a chemist rather than a biologist. While Pasteur's reputation will rest upon his work in biology he was educated as a chemist, and to this education we may attribute no little of the uniformity of the success of experiments. The science of biology is extremely inexact. Owing to the complicated conditions of life one is ever expecting to find exceptions to the general rules, and our scientists have found it utterly impossible to lay down absolute definitions or any absolute lines of distinction between groups in biological phenomena. The very essence of biological science is the fact that the phenomena grade into each other. Influenced by this fundamental principle, biologists have commonly fallen into a habit of slackness in dealing with phenomena. Knowing that whatsoever law they may discover will be sure to have its modifications, its variations, and its exceptions, they inevitably get into the habit of feeling that an approximation toward accuracy is almost sufficient. Now, the peculiar nature of the field of experimentation in bacteriology demands above all things most rigid accuracy. His training as an analytical chemist gave to Pasteur a recognition of the importance of exactness. One who has carried on experiments in molecular physics recognises that failure is sure to result from inaccuracy; and it was the fact that until he was 30 years of age Pasteur was trained in this kind of accurate experimental manipulation that, when he turned his attention finally to biology and problems connected with the microscopical world, his methods of experimentation and the results of the experiment showed at once a vast advance over those of all of the biologists which had preceded him. For the first time accuracy began to be seen in this field.

A second striking feature in Pasteur's life was its dramatic character. One hardly looks for the dramatic in the achievement of scientific results. But Pasteur was a Frenchman, and, although thoroughly modest, he was, like other Frenchmen, alive to the advantage of public demonstrations. As we look through his life we can see him taking many and many an opportunity of presenting his scientific results in as dramatic a style as possible. Meeting with opposition almost constantly during the years of his active investigations, time and time again he planned public tests in which his results should be brought before the public eye for demonstration in such a fashion as to appeal in a striking manner to the world. No other scientist has ever achieved so many brilliant public successes.

We must above all things learn from Pasteur's life that, after all, the chief reason that his reputation advanced so rapidly in the comparatively few years of his active work, was in no small measure the fact, that he had the wisdom to see that it is to the application of science to practical life, that the world in general gives the greatest admiration. There is ever a tendency among scientists to belittle one of their number who attempts to apply to practical life the results of research. In spite of every plea that may be made for pure science, it is the application of science to the life of man that has the greatest interest to mankind. As we look through Pasteur's life and study the growth of his wide reputation, we shall find that his reputation was largely founded upon the brilliant epochs in his history, where he applied to practical subjects the results of the scientific investigation. The advance in his reputation came at those occasions, when the public learned of his work, because it had been applied to something that interested the world. The homage that the world has given to Pasteur testifies to the value of practical science, testifies to the truth of the position that pure science is of value to man chiefly as it can be applied to facts which influence practical life. While, then, applied science is frequently mentioned with a slight disdain by the modern advanced scientist, it is well to remember that Pasteur, whose reputation as a scientist has perhaps outranked that of any man of the last fifty years, made his reputation and achieved his world-wide fame, because he applied to the practical

things of life the discoveries revealed to him by his microscope.

The active part of Pasteur's life was so full of investigations in many lines that it is impossible that they should, in a brief review, receive the weight which they deserve. Only the most important of them can be here mentioned, a selection being made of those upon which his reputation has been chiefly built. Pasteur received an early training as a chemist, and the first work of his life was chemical. Until he had reached about the age of 32 the work he had been doing had been mostly in the line of molecular physics, and certain papers upon the structure of crystals appeared from his pen, which even in those early years showed signs of genius. He would probably have made his mark as a chemist had not his attention been turned to a more fruitful field. In 1854 he was appointed Dean of the University of Lille, and it was at this place that his attention was first turned in the direction which subsequently made him famous.

A simple incident led him to the study of fermentations in the manufacture of certain chemicals. The crystallisation of tartrates had earlier interested him, but now he noticed that tartrate of lime had a tendency to ferment. This fact attracted his attention, and led him into observations and experiments upon the nature of the fermentation of tartrates. These experiments demonstrated to his microscope the universal presence of living organisms in the fermenting material. Finding these fermentations universally accompanied by living organisms, it appeared to him as probable that the fact must be part of some general law. It was not a pure accident that living organisms were present, but in some way he believed there was a connection between the fermentations and the presence of the organisms. A general law he formulated, and reached the inference that fermentations in general are produced by living organisms, microscopical in size, but of very great potency. This conclusion was, of course, a simple inference as yet undemonstrated, but it was the inference which started Pasteur along the line of his experiments in fermentation. It was the guiding star of Pasteur's life. From the moment the inference was drawn until his death, this law—that fermentations, putrefactions, and all similar chemical changes were produced by the growth of micro-organisms—was the basis of every line of investi-

gation which was undertaken by him. Every new problem in his life was attacked by him from this standpoint. The great success of Pasteur's work lay in the fact that his guiding principle was a correct one, his great merit in his wisdom in early adopting it as a law, and his genius in demonstrating it. If he had drawn an inaccurate conclusion from these early experiments, he might in time have corrected the error, but we must look upon the fact that he had the wisdom to draw a correct inference from this first work as the foundation of Pasteur's success in life.

Pasteur now became interested in the subject of fermentation. His home was in one of the important seats of fermentative industries, and study of fermentation as a general phenomenon at once received his attention, not only from its general interest, but as especially appropriate to his life at Lille. He was thus led away from the line of pure chemistry into biological work, but the change was almost imperceptible. Up to the time when Pasteur began his studies, fermentation had been regarded as a chemical phenomenon, and it was natural that a chemist should study it. In the few decades that preceded the work of Pasteur, fermentation had been carefully studied by a number of our chemists and microscopists. While different theories had been advanced, the theory of fermentation, which was almost universally held at the time when Pasteur began his experiments, was that of the chemist Liebig, and was a purely chemical theory. In accordance with this theory of Liebig, fermentation is simply the chemical decomposition of bodies produced by the unstable equilibrium of their molecules. This theory held that the molecules of fermentable materials were very unstable, and were easily broken to pieces into simpler compounds. The ferment was held to be simply an exciting cause which started this chemical decomposition. Fermentation was thus a purely chemical subject at the time when Pasteur began his studies, and the first work which he attempted was to show that the chemical theory of the scientists of his day should be replaced by the physiological or biological theory, which he was convinced from his experiments was the correct one. Upon this task he set himself at once, and by the study of the lactic fermentation of milk, the butyric fermentation of milk, the acetic acid fermentation in the manufacture of vinegar, and by the

numerous careful experiments along these various lines which he devised in his laboratory, it required only four or five years for him to undermine completely the chemical theory of Liebig, and to put in its place (on a somewhat unstable basis at first, perhaps) the theory that all types of fermentation are organic in their nature and produced by the life of microscopic organisms. Even at this early day we can see his recognition of the value of the practical application of science, for among the very early pieces of work which he performed was the study of the acetic acid fermentation in the making of vinegar, and by a practical application of his results to this industry he developed a vast improvement in the manufacture of vinegar and a great cheapening of the process.

Pasteur had thus made something *his own*, and at this date, in the vicinity of 1860, he became recognised as the exponent of the biological theory of fermentation. From this time he progressed rapidly. The fermentation of wine next claimed his attention. Here was a second fermentative industry, in which unexplained difficulties were constantly occurring. He soon found the cause of the various failures of the vintner, by which were produced many of the so-called "diseases of wine." These diseases, he found, were all due to the presence of improper micro-organisms during the fermentation instead of the pure fermenting yeasts, and he quickly devised a remedy for them in a process that has subsequently been known by his name as the process of *pasteurisation.* This method of preventing the evils, involving the heating of wine, was received with great opposition, on the ground that the heating injured the flavour. After a great deal of more or less violent disputing on the matter, Pasteur arranged for a public test of the question by getting together a large number of experts and convincing them against their will, by ingeniously devised deceits, that they were unable to distinguish between wines that had been pasteurised by his process and wines that had not been subject to heat. Having previously shown that the method of pasteurisation was almost a sure remedy against the various diseases, this first public demonstration was thus a brilliant success, and at once obtained for his method the acceptance of the vintner.

Meantime, he had been giving his attention to the vexed problem of the last two or three centuries—namely, the ques-

tion of spontaneous generation. Believing, as he did, that all fermentation was caused by micro-organisms, it was a foregone conclusion that he would be an opponent to the view of spontaneous generation. The studies upon fermentation which he had been carrying on, and his accurate methods, trained him especially well for this subject of spontaneous generation, and the experiments which he instituted brought this question into the condition of demonstration. The experiments of early scientists were repeated by him with greater care; many new experiments of his own were devised; the microscope was brought into requisition in new ways. A brilliant conclusion was reached, that by the exercise of sufficient care all traces of life could be avoided, and no spontaneous generation ever occurred. It is true that the conclusions of Pasteur were not at once everywhere accepted. In England, particularly, objectors arose who advocated a belief in spontaneous generation, and these objections were not silenced until the English physicist, Tyndall, took up the experiments that Pasteur had been making, and even more satisfactorily reached the same conclusion. But Tyndall's results were only those that Pasteur had reached before, and we recognise to-day that the only basis of the objections that were made to Pasteur's conclusions was the inaccuracy and lack of care with which his opponents performed their experiments. With brilliant rhetoric and loose experimenting, spontaneous generation was still advocated, but the disproof was given by Pasteur in spite of the fact that opposition still arose after the disproof had been reached.

But now Pasteur's attention was to be turned again, and in a direction that again changed his whole life and has revolutionised modern medicine. One of the great industries of France is that of the silkworm raising. About 1850 there appeared upon the silkworm farms a disease of the silkworm known as pèbrine. This disease spread rapidly from farm to farm, greatly reduced the productions of the silkworm farms, and actually threatened the entire destruction of the silkworm industry. From 57,000,000 pounds per year, in thirteen years this industry had fallen to 8,000,000 pounds, all because of the great devastation produced by this disease. Many had been the attempts made to cure it and many the attempts made to discover its cause. Men with a

reputation greater than that possessed by Pasteur, at the time, had attacked the problem and failed. In the year 1865 no remedy had been discovered, no cause was known, and the silkworm industry was threatened with immediate destruction. Pasteur was asked to investigate the question, and at first refused to do so. His success in the study of fermentation had opened to him a prosperous career; he knew nothing whatsoever of silkworm raising, and he was afraid that the investigation, even if successful, would lead him too far from his own chosen line of work. He was, however, over-persuaded, and finally accepted the task of investigating pèbrine, little thinking that it was only the continuation of his studies on fermentation, and that along the line opened to him by this investigation he was to find his life-work and world-wide reputation. Pasteur undertook the investigation of pèbrine already prepared for his discoveries, for living micro-organisms were for him potent agents in nature. He very soon discovered that the cause of the disease was a microscopic organism living in the moth. He was not the first to discover this organism, for others had seen it and described it.

That Pasteur succeeded where others failed was due to the fact of his belief in the powers of the microscopic world. Others regarded these organisms of no importance, but Pasteur had become so imbued by his study of fermentation with the important agency of microscopic organisms, that the very first question that he asked was whether living bodies were not the cause of the disease that he had been set to investigate. If organisms could produce fermentations in dead material, why might they not produce disease in living creatures? The result of his work here we need not dwell upon. It was a brilliant success. It demonstrated that the disease was caused by the organisms, and it devised a remedy against the trouble by simply breeding from healthy moths. The world laughed at him; those interested in the silkworm industry refused to adopt his methods, as those of a fanatical microscopist, and too simple. He met at first with nothing but opposition, but the man arose to the occasion, and so sure was he that he was right that he again arranged for a public demonstration. An abandoned silkworm farm was put into his hands, and, although at the time an invalid and unable to travel

by ordinary means, he had himself transported across France and personally directed the work on this silkworm farm, although he was unable to do anything himself.

It is not, perhaps, generally known that from this time to his death Pasteur was partially paralysed and unable to perform the work of his own experiments. There is something truly pathetic and dramatic as we think of him, an invalid, simply capable of directing others in their work, and yet fired with the belief that he was right, and with the determination to convince the world that he was right. Again Pasteur's genius demonstrated itself, and, by using his simple remedy, in a short time this silkworm farm, abandoned because of the presence of the disease, was restored to a condition in which it was one of the best-paying silkworm farms in France. The disease was practically eradicated from it. With a bound Pasteur's reputation spread throughout France and the world. The silkworm industry in France began to adopt his methods at once and rapidly assumed its old condition of prosperity. From now on the Frenchmen were ready to accept almost anything that Pasteur would say. He had saved them their beloved silkworm industry, and had been the means of saving to the peasants of France a sum of money almost beyond belief.

The next important work in Pasteur's life was his investigations upon the subject of the fermentations of beer. The Franco-Prussian war and its results had deprived the French people of their beer-makers, who had been largely German, and when the French people began to make their own beer they found themselves for awhile in difficulties. In spite of careful methods, various imperfections in fermentations were of frequent occurrence. By this time the French public had become confident in Pasteur's abilities, and it was only natural that he should be requested to find the solution for this puzzle. As usual, success attended his efforts. His microscope soon showed him that the trouble was due to the use of impure yeasts. The brewer's yeast was liable to be mixed with various species of bacteria as well as improper species of yeasts, and his genius soon showed methods of removing the difficulties and bringing the fermentative industry into a condition of uniformity. Upon the basis of these experiments has been founded the whole of our modern brewing

industries. The large brewery of to-day is impossible without the microscope, and to the stimulus given by these discoveries of Pasteur has been due the great centralisation of brewing.

The next problem that attracted the attention of Pasteur was the dreaded anthrax. For several years this devastating disease had been the subject of scientific investigation. Already its connection with micro-organisms had been made probable, and indeed had been demonstrated. Many problems had been solved, but many still remain to be solved in connection with this pestilence of the agriculturist. As usual, Pasteur began at the beginning, taking nothing for granted, even of the facts that had been essentially demonstrated. His experiments resulted in a more complete demonstration of the relation between the anthrax bacillus and the disease, showed the method of action of the germ, demonstrated the source from which it was frequently derived by cattle, differentiated between this disease and one or two others closely resembling it among animals, disproved all of the objections that had been raised by those who disbelieved in the casual nature of the bacilli, and, in short, brought this subject upon the same sure foundation as that of pèbrine which he had so triumphantly solved ten years before. Nor was this all. The greatest discovery of his life was to follow. To Pasteur's peculiar trait of mind it was not enough to discover the cause without searching for the remedy. It was the *practical* question which appealed to him. Pasteur recognised the fact that in the human race one attack of an infectious disease frequently renders an individual immune against a second attack. He also remembered that protection against small pox had been known to be produced by vaccination.

Acting upon these suggestions the questions arose in his mind whether it was not possible to give to domestic animals, subject to this devastating disease, a milder type of the disease in question, from which they should readily recover, but which would give them immunity against a second attack. The principle was a new one, and outlined a new, bold plunge into the mysteries of nature. It was not, however, in the investigations of anthrax that the remedy first suggested itself, but rather in a side investigation upon the subject of another germ disease known as fowl cholera. Every

one is familiar with the results. He discovered a method of rendering the invading organisms of fowl cholera so impaired in their action as to be unable to produce death, giving rise, on the contrary, simply to a slight indisposition; but demonstration soon showed him that this slight indisposition was followed by immunity against the more severe disease. To anthrax he turned the same line of investigation, and after patient, laborious search discovered a means of rendering the anthrax germ impaired in its vigour. His preliminary experiments convinced him that he had achieved success, and then came one of those dramatic public exhibitions in which Pasteur so delighted, and which have so impressed the world. Almost before the public had learned that he had obtained a possible method of preventing this dread disease among agriculturists, Pasteur made arrangements for a public test of his method, and in the presence of an audience of some two hundred experts, made up of physicians, veterinarians, Senators, prefects, farmers, members of the French Academy, and others of high standing, he demonstrated by a simple experiment, lasting about a week, that he could, with unerring certainty, prevent cattle from acquiring anthrax; that he could give to them a practically absolute immunity against this almost surely fatal disease, by infecting them with a very mild indisposition a few days before. The effect upon the audience was electrical, and their enthusiasm knew no bounds.

Pasteur's experiments spread at once over the world, and from this further practical application of his scientific research his reputation made another advance. His anthrax vaccine was distributed through the civilised world, was used by grazing communities everywhere, and it has been thought to have saved the lives of hundreds of thousands of cattle. The greatness of this discovery can hardly be appreciated to-day. It was a logical discovery of a new method of meeting disease. While other even more valuable discoveries in the same line have followed and are still to follow, none can equal in significance this first application of the studies of the microscope to the treatment of disease.

Following the work upon anthrax, various other lines of bacteriological research connected with diseases of animals attracted his attention and demanded his time. It was not, however, until he had attacked the problem of the most dreaded of all human dis-

eases, hydrophobia, that he again attracted the public eye. His experiments upon hydrophobia were, perhaps, the boldest in the line of experimentation that had ever occurred, for here for the first time in history laboratory experiments were transferred to the human being. Hydrophobia had fascinated Pasteur for a long time. Experimental work had shown him that the disease was not a purely nervous excitation, as had been claimed, but that there was an actual disease under this name. Experiments showed him further that the disease bears every similarity to infectious germ diseases, although neither he nor anyone else, even to the present day, have succeeded in demonstrating the organism which produces the diseases. Experiments upon dogs and rabbits in his laboratory followed each other rapidly, and, with his usual genius, he devised many a method of hastening the experiments, and of rapidly teaching results which would normally take months.

His success with other diseases made him ambitious also to find a method of preventing this disease, and, while the methods which he had used in fowl cholera and anthrax proved useless in the case of hydrophobia, the same general line of work led him finally to a method of inoculating animals which rendered them immune against this disease. Not only so, but the same method, when applied in a slightly different way, was found to be efficacious in warding off the disease in an animal which had been previously inoculated therewith. He found himself able, with certainty, to inoculate an animal with hydrophobia, and then, by treating him with the various subdermic injections which he had devised, prevent the appearance of the disease which would have otherwise inevitably occurred. Laboratory experiments were a success, and next, the bold step was taken of applying to mankind laboratory methods, which had been hitherto tried upon animals alone. A youth who had been severely bitten by an unquestionably rabid dog was brought to him at his laboratory. The youth's life was despaired of by the physicians, inasmuch as with certainty he would develop hydrophobia. Under the circumstances Pasteur felt justified in trying upon this youth the experiments that had succeeded with dogs and rabbits. The experiment so far as could be demonstrated was a success. The youth failed to develop this disease.

But for a final demonstration that his methods were successful, was required a long series of public experiments which were not to be obtained by any one dramatic incident. To obtain such testimony no means appeared to be possible except to announce to the public the discovery of a method of preventing hydrophobia. Such an announcement was made by Pasteur. The public had such unlimited confidence in the man that they at once accepted the conclusion as correct. Certain it is that no one else could have taken the public into his experiments, but his uninterrupted success in previous years gave all a belief that he had made no mistake here. Opportunities for experiment began to multiply, and scores and then hundreds of individuals who had been bitten by animals, either rabid or supposed to be rabid, flocked to the laboratory of Pasteur to be treated by his method.

The experiments thus begun have continued for eight years, and even yet can hardly be considered as concluded. The opinion of the public, and especially of the medical world, has vibrated from one side to the other. At first, Pasteur's conclusions were accepted as probable, simply on the basis of the great reputation of the man, and the fact that Pasteur made so few mistakes. Later, flying to the other extreme, the whole efficacy of the method as practised by Pasteur was doubted. Most violent opposition arose, and it is thought that this opposition contributed to undermine Pasteur's health and check his active life. Later again the world became slowly convinced, by the accumulating testimony in his Institute, that here too no mistake had been made.

At the present time there is hardly a question that Pasteur's methods, even in the case of hydrophobia, have demonstrated themselves as successful. While statistics are a very uncertain kind of evidence, one cannot read of the success which has attended the inoculation in Pasteur's Institute for eight years without being convinced that Pasteur's methods are correct. In his Institute have been treated several thousands of cases of persons bitten by animals supposed to have been rabid, and among those that have been treated the number of deaths has only been a trifle over one per cent. With this exceptionally small per centage, even after we say everything possible as to the uncertainty of statistics, we can hardly question that truth underlies these

methods, and that Pasteur's last great work was as successful as those of his earlier years.

This work upon hydrophobia was the last piece of work which we have directly from Pasteur's own personality. A Pasteur Institute was established, and from that Institute has come, and is still coming, a series of investigations along the lines that Pasteur began, which are yearly adding, not only to our scientific knowledge, but to our practical method of dealing with disease. While Pasteur's name is no longer attached to these individual researches, the master's hand gave the inspiration for them all. For several years the experiments have all been in the hands of his assistants. While we have looked upon them as his assistants, we must recognise them as independent and as having achieved their own reputation; but, nevertheless, we must feel that the work that has come from Pasteur's Institute, and that will for a number of years be given to the world from that source, must be directly or indirectly attributed to the inspiration of the master for whom the Institute was founded.

The world's debt to Pasteur we never can estimate. His financial gifts we can realise when we remember that he saved the silkworm industry, that he taught the vintners how to make wine, that he established the fermentative industry the world over, and that he gave to the agriculturists a method of preventing anthrax; we can see that the financial value of his life to the world was far beyond that of any other person that ever lived. The debt of theoretical science to him is equally great, though not measurable in any terms. He disclosed a new world; he discovered a new series of phenomena taking place below the realm of human vision, and he opened to the world a new field of science. To medicine again his gifts were beyond measure. To him more than to any other is due the demonstration of the germ nature of disease, and to his work we owe our hopes for medical science in the future. The practice of medicine has been almost purely empirical. To-day we are hoping that it is gradually becoming a matter of science. As we know the causes so we can search for the remedies against disease, and to Pasteur is due the first attempt to place medicine upon a scientific basis. Surgery has already become a science, and this too is indirectly attributable to him. While modern sur-

gical methods were developed by Lister, the methods of Lister were devised as the result of the study of Pasteur's work in fermentation. Pasteur has opened to us a new world and given to us a new science, has established upon a firm basis a science of medicine and a science of surgery, and has added to the financial stores of the world accumulations of great magnitude. It was all done by slow work. The field was not a new one, for already investigators had made inroads therein, but no one with anything like certainty and accuracy.

For years it was Pasteur alone who was capable of investigating bacteriologically with anything like a certainty of successful issues. Bacteriological methods were too difficult to be handled by anyone but a master. To-day it is true the methods have been so simplified that far less genius has been required to handle them, and to-day the bacteriologist has multiplied in every direction. But at the time when Pasteur was the pioneer, the methods were so difficult as to be beyond the reach of any except those of the greatest genius. Nor can we measure our debt to Pasteur by his own work. This, indeed, was great, but our debt to him must be also measured by the work of followers who were inspired by him. In France, in England, in Germany, in America, we find the study into this realm of the microscope inspired by the long, laborious, and successful work of the French master. Even in the latest achievement, the use of antitoxine, we have the direct result of Pasteur's life. Where one leads others may follow.

For a long time Pasteur stood alone, and it was only work that he had done that could be looked upon as demonstrated. Little by little, however, others came into the line of research, and when to-day Pasteur is taken from the field of activity there are many capable of carrying on his work. No man that France has created is so worthy of her pride. No man who has lived in history has done so much for humanity. No one who has lived will be remembered by posterity as having had such an influence upon the world in the way of discovering facts which advance the health and prosperity of mankind. But, perhaps, the proudest achievement he attained, viewed from the standpoint of a scientist, was earning the right to the claim that "*Pasteur never makes mistakes.*"

Diatomology as an Aid to Geology.

By M. J. Tempere.*

WHO would maintain at the present time that the study of Diatoms is of small importance, and not recognise that as much and even more than any branch of Cryptogamia it has a right to be classed among those which can powerfully aid the researches into the secrets of Nature that are the most difficult of solution?

Diatomology exists. It is a science which nevertheless has not received the unanimous sanction of learned men, for in the best treatises on Botany there is scarcely any mention of Diatoms and of their importance in Nature.

The study of Algæ in general, of Mosses, Fungi, and of Lichens, is honoured everywhere. There is not a university, a faculty, or a large school, that does not reckon among its savants those who occupy themselves with the different branches of cryptogamic botany; but of Diatoms, none!—at least in France, for among foreigners I could mention many, among whom are two of our collaborators.

The reasons that I have heard given as an excuse for this neglect appears to me so ill-founded that they are hardly worth noticing; some of them even appear to me to be only the expression of one who will not discuss the question.

In our last number I mentioned the observation made by Prof. P. T. Cleve, of Upsala, on the identity of the species found on the coast of Greenland and on the north of Asia, giving rise to the idea of a current between the two opposite points, and thus aiding the solution of a hydrographical problem.

To-day, by the reading of a brochure having the title, *Preliminary Report on the Physical Geography of the Littorina Sea*, by Henry Munthe (a work published in the *Bulletin of the Geological Society of Upsala*, No. 3, Vol. II., 1894), I have seen with pleasure that at length a geological savant, not content to borrow from Palæontology for proofs in aid of his deductions, relating to the successive changes to which the Baltic Sea has been subjected,

* *Le Diatomiste*, II., 1894, pp. 129—130.

has appealed to Diatomology by requesting our colleague, Prof. P. T. Cleve, to study the species contained in those beds which present distinct characters of these transformations, so that he may be able to add another proof to those which he has already obtained.

Already for some time researches and comparative studies have been undertaken by a certain number of diatomists with this object in view, and I am certain that from these studies the importance of Diatomology will result, and that one day they will place it in the first rank.

The recent labours of Dr. P. Miguel have evidently contributed much to this end, in offering to diatomists new methods of study, which enable them to follow the different phases of the life of these organisms, their transformations, and to compare that which they can obtain in their laboratories with that which Nature presents.

Preparing Orthoptera.

IN Special Bulletin No. 2 from the Department of Entomology of the University of Nebraska, Prof. Lawrence Bruner gives excellent directions for collecting and preserving Orthoptera. Regarding the process of stuffing he says: Within the past few years most of the objections that had so frequently been made to the gathering and preservation of orthopterous insects, have practically been removed by the adoption of different and better methods of preparing and preserving these creatures. A few of our specialists only seem to have profited from the discovery that these insects can be handled 'taxidermically,' *i.e.*, be stuffed in a similar manner as we would adopt for birds, reptiles, and mammals, and thereby preserved, in collections equally well with other forms. The following directions for collecting, cleaning, and 'stuffing' orthopterous insects may, therefore, be of much value to those who contemplate making collections of, and studying these insects :—

Instead of throwing the specimens in spirits (alcohol, brandy, whisky, etc.), when captured they should be killed in the 'cyanide'

bottle, from which they should be removed soon after death, and at once opened, cleaned, and stuffed; or they can be transferred to a small tin or other box, where they may be kept moist and flexible till arrived at home or in camp. Now take the specimens one at a time in the left hand, and with a fine, sharp-pointed scissors open the abdomen by cutting across the middle of the two basal segments on the lower side, then reverse and cut the opening a trifle larger by nearly severing the third segment. After this has been done extract all the insides (intestines, crop, ovaries, etc.) along with the juices, using a fine pointed forceps for the purpose; wipe out the inside of the insect with a small wad of cotton, and it is ready to be 'stuffed' or filled up. When this latter is done the insect may be either pinned into a box prepared for the purpose at once, or it can be wrapped in paper and packed away for future use.

To "stuff," cut some cotton bat (raw cotton) in short pieces, and fill up the insect through the opening previously made for cleaning it, using the same or a similar pair of forceps for the purpose, taking care not to fill too full nor to stretch the abdomen beyond its original dimensions. When the filling is completed carefully draw the edges of the several segments together, and gently press the sides of the abdomen into shape with the fingers. This can all be done after a little practice in about four or five minutes' time. The advantages in favour of a specimen thus handled are several. It will not decay nor turn dark. The original colours will be retained more nearly perfect, and there is but little danger, under ordinarily careful treatment, of its being attacked in future by the museum parts mentioned. Specimens, when thus prepared by an expert and properly labelled, are worth three or four times as much for cabinet specimens as those not so cared for. Especially is this true with reference to specimens collected in warm, moist climates where decay is rapid, and where mould is sure to attack specimens that are long in drying.—*American Naturalist.*

Predacious & Parasitic Enemies of Aphides (Including a Study of Hyper-Parasites).

BY H. C. A. VINE.

PART III.—*(concluded).* PLATES I. AND II.

IN the foregoing studies of Aphis-eating insects which have appeared in these pages, I have endeavoured to show the connection of each of the species under immediate observation with those nearly allied to it, and at the same time to indicate the position held by the particular group in the systems of classification which have been established by leading naturalists.

In order to follow this course with the Neuropterous Aphis-eaters, it is necessary to go somewhat further. The position of the typical forms of the order has long been the subject of dispute, and as it involves the question whether or not the Aphis-eating families are to become the types of the order, it perhaps will not weary the reader too much to examine in the present section some of the evidence bearing upon this important point

I have already alluded to the very remarkable and wide differences of structural detail in the species of the *Neuroptera*, and these, combined with the fact that a number of families undergo what has been called an 'incomplete' metamorphosis, have led many naturalists to pass by the strongly marked features connecting the dragon-flies and allied sections with the lace-wings and caddis-flies, and to transfer all those species which are active, and continue to feed, during their pupal existence, to the *Orthoptera*, the 'incomplete' metamorphoses of which are, however, of a very different type to those of the species which it is thus proposed to associate with them.

To discuss at length the whole question of the value of the form of metamorphosis as an ordinal character would be beyond my present scope, and would import into my subject much that would be wholly unconnected with it; but before passing on we may usefully glance at some important points, and note the views which have been expressed by naturalists who have been favoured with especial opportunity of forming correct conclusions.

Mr. G. B. Buckton, in his recently published work on one of

the *Syrphidæ* (*Eristalis tenax*) says of larval adaptation generally: "Adverse surroundings may be successfully combated by larvæ, and we may therefore conceive that certain organs may become profoundly modified so as to meet the requirements necessary for the struggle in life. The study of larval history will thus appear to become more and more important, as these facts are generally admitted."

Sir John Lubbock, in his excellent treatise on the *Origin and Metamorphoses of Insects*, maintains the proposition "that the form of the larva depends very much on the conditions of life," and after an able argument, based on many apt examples, he concludes "that the form of the larva in insects, whenever it departs from the hexapod *Campodia* type, has been modified by the conditions under which it lives. The external forces acting upon it are different from those which affect the mature form, and thus changes are produced in the young which have reference to its immediate wants rather than to its final form."

"And lastly, as a consequence, that metamorphoses may be divided into two kinds—developmental and adaptional or adaptive." In another place the same writer says:—"The metamorphoses of insects depend then primarily on the fact that the young quit the egg at a more or less early stage of development; and that consequently the external forces acting upon them in this state are very different from those by which they are affected when they arrive at maturity."

For my own part, I find it somewhat difficult to see how, granting an evolutionary origin of species, a variation in the mode of development, such as the 'incomplete' metamorphosis presents, can be made a ground for separating insects which are so clearly connected by important points of general structure, by wing venation, and by resemblance of larval form and food (albeit one is adapted for aquatic and the other for terrestrial existence), as *Calepteryx* and *Myrmeleon*, which are shown on Plate I., at Figs. 1 and 2.

Moreover, I would emphasise most strongly the point that the metamorphoses of insects, although they have been divided into four distinct stages by so many generations of naturalists that their definite existence has become almost an article of faith, are in

reality by no means so sudden as is generally thought. The observant student will recognise *that* they are merely stages in a series of developments, often aberrant in a most remarkable degree (as, for instance, in the case of *Sitaris*), but always progressive, and *that* the apparent arrest of the pupal stage is due to the changes attending the development of the perfect insect within the larva having become so extensive and so rapid that it would be impossible for the functions of the latter to be continued further. The conversion of the grub into the fly has commenced long before the pupal stage is entered upon, and in many of the orders the casting of the larval skin marks successive advances in the development of structure which ultimately go to form the perfect imago. A marked instance of this has already been given in these pages in reference to the larva of *Coccinella bipunctata*, Vol. IV., p. 292, and in the plate accompanying I have shown the tarsus of the imago already perfected within the limb of the *larva*. Indeed, in very many instances, the careful examination of a larva when approaching its full growth will reveal much of the structure of the imago well advanced within it.

The larvæ of the Orthoptera, as a whole, closely resemble their parents in habit and also in anatomical structure, with the exception of the absence of wings. They frequent the same surroundings, the organs of the mouth are the same, and their nutriment is of a similar character throughout their existence. To quote once again from Sir John Lubbock :—"In the wingless species of the Orthoptera there is little external difference, excepting in size, between the young larva and the perfect insect. The growth is gradual, and there is nothing which would in ordinary language be called a metamorphosis. In the majority of Orthoptera—though the presence of wings produces a marked difference between the larva and the imago—the habits are nearly the same throughout life, and consequently the action of external circumstances affects the larva in the same manner as it does the perfect insect."

But among the Dragon flies and their allies the larvæ differ in almost the widest possible sense from the imagines which spring from them. Specially adapted for aquatic existence, provided with branchial respiration and with swimming feet, the only

character which they possess in common with the perfect insect is the rapacious appetite which impels them to attack the other inhabitants of their haunts. The imago, on the other hand, is one of the most beautiful of insects, fulfilling an aërial existence and provided in the most perfect manner with tracheal respiration and ample wings. "The larvæ do not live under the same conditions as the perfect insects. External forces accordingly affect them in a different manner, and we have seen that they pass through some changes which bear no reference to the form of the perfect insect. These changes are, however, for the most part very gradual."

These broad characters seem to militate strongly against associating the *Odonata* with the *Orthoptera*; but when we consider also that, although differing in environment and in certain characters of an adaptive nature, incidental to their surroundings, the larvæ of the *Odonata* strongly resemble those of the *Planipennia* in general form, in the provision of special mouth structure for an actively carnivorous existence, and in the unwearied hunt after prey, it is hardly possible to escape the conclusion that a near relationship exists between these two groups, and that on these grounds the Linnean arrangement of the Neuroptera should hold good.

In the *Trichoptera* (which is an essentially Neuropterous group) and in the *Raphidiidæ* we find that the pupæ, though in a great degree quiescent, are, during their later stages, sufficiently active to walk about, thus presenting an intermediate link between the silk-wrapped chrysalis of *Hemerobius* and the active 'pupa' of *Libellula*. The *Trichoptera* also present, in their habit of catching their prey, many points of resemblance to the Ant-Lions, which will not be without interest to an observant student; and in wing structure they seem in some respects to favour the venation of *Agrion* and in others that of *Hemerobius*.

To summarise, I am clearly of opinion that, given the principle of evolution (and we are told by Carl Vogt, "personne, en Europe au moins, n'ose plus soutenir la Création indepéndante et de toutes pièces des espèces"), the nature of the metamorphosis in the Neuroptera is only a question of development, and that any particular modification may well arise in any group when the condi-

tions of life are such as to render the change essential to continued existence.

Passing from the consideration of the metamorphosis, we will now examine the second ground on which the removal of the Dragon-flies from the *Neuroptera* to the *Orthoptera* has been supported.

Mr. W. S. Dallas tells us that "one character almost universally holds good, and this is derived from the structure of the *ligula*. Throughout the more highly organised Orthoptera the ligula is, almost without exception, divided or cleft in front either in two or four lobes, and the indications of division may even continue down into the basal part of the labium, showing very clearly the original construction of the whole labium from a pair of organs similar to the maxillæ. In the true Neuroptera, although the ligula is occasionally cleft in front, the general rule is that the parts of the labium are united in the middle line so closely as to entirely conceal the original construction of the organ of two lateral halves, so that the labium really approaches more nearly to that of the Beetles than to that of the Orthoptera."

This expresses pretty succinctly the views of those naturalists who propose to break up the *Neuroptera* as arranged by Linnæus, and to place the most important sections with the *Orthoptera*. As I have already pointed out, in this event the Aphis-eating *Hemerobiidæ* and *Chrysopidæ* would become the typical genera of the remaining Neuroptera. To arrive at a correct conclusion as to the value of the structure of the labium in this group, I have examined and drawn as many examples of the different species as possible during the past few months, with the result that I am disinclined to recognise it as of any weight as an ordinal character, although as a generic feature it is a most useful guide.

On Plates I. and II., I have reproduced my drawings with as much delicacy and exactness as the lithographic process employed admits, and in addition to the labia of *Agrion*, *Libellula*, *Hemerobius*, and *Sialis* among the Neuroptera, the reader will find the same organ as found in the House Cricket *(Gryllus domesticus)* and the Earwig *(Forficularia auricularia)*, as representatives of the Orthoptera.

In the labium of *Sialis lutaria* (Pl. II., Fig. 2), which is

seen from above, the nearest approach to the Coleoptera may be discerned, the organ consisting apparently of a single lobe of slight thickness and covered with short hairs. It is without any external indication of division, and in the drawing is shown partly hidden beneath an extensive organ, which appears to represent the true ligula. Possibly, it is this which has led naturalists to recognise a resemblance to the general structure of similar parts in the Orthoptera.

In the labium of *Hemerobius*, which is shown at Fig. 1 on the same plate, we have a far more normal structure. Here the central lobe, which appears to be without any trace of division, is flanked on either side by a smaller lobe, the divisions being very clearly cut down to nearly the centre of the organ. It is also pretty evident, on careful examination, that some kind of bi-lateral structure exists in the central lobe, though, as I have said, there is no sign of division externally. It resembles the same organ in *Sialis* in its short, stout hairs and in the presence of a superior lobe, which must be assumed to be the homologue of the ligula of the Diptera. Here, then, in one of the most typical families of the *Plannipennia*, we have a labium, deeply divided, and of a form widely differing from that of the typical *Coleoptera*. Indeed, I have been more than once inclined to suspect the existence of obsolete or partly atrophied structure resembling the pseudo tracheæ of the *Diptera*.

In Fig. 3 it will be seen that the labium of *Agrion* partakes even less of the structure of the *Orthoptera* than that of *Hemerobius* does of the Coleopterous formation. In it the middle division scarcely extends beyond a notch on the frontal edge, and although the form and arrangement of the hairs suggest the labium of the former order rather than that of a beetle, yet the general structure is so utterly at variance with that prevailing among the Orthoptera that it will scarcely be necessary to pursue the comparison further.

In *Libellula* (Fig. 4) we find an organ which, under some circumstances, may be thought to present a definite resemblance to the Orthoptera in regard to the central division. But a careful examination of the exterior (ventral) surface, in a natural condition, reveals no more than an axial depression, which it is difficult to believe can represent a true division into lobes; and an examina-

tion of the upper, or inner, surface seems to show that the membrane is not divided. But on examination by transmitted light, and particularly in a transparent medium, such as Canada balsam, and after treatment by potash, a chitinous division is very apparent, and it becomes clear that we have to do with an organ which, although perhaps not actually bilobular, approaches so nearly to it as to have caused observers (viewing it in a transparent condition) to conclude at once that it presented a definite Orthopterous character of genuine significance. The chitinous rigidity, however, is very different to the fleshy organ of the cricket (Pl. I., Fig. 6) and similar Orthoptera, while the structural arrangement of the parts presents no analogy, and although an approach to the orthopterous central division must be admitted, it is by no means clear that the structure of the labium as a whole is such as to support any ordinal transference of the genus.

For better comparison of these organs with those of the Orthoptera, I have figured upon Pl. I., at Fig. 6, the labium of the House Cricket, which, it will be observed, is a thick fleshy organ, supported on a muscular and flexible column, and provided with muscles beneath the frontal lobes, by which they are controlled. And on Pl. II., at Fig. 5, may be seen the drawing of the labium of the Common Earwig, in which the organ is so completely divided and altered in character, that it assumes the form of two thickened single-jointed palpi. The fleshy lobes of the Cricket present some slight resemblance in shape to the same organ in certain of the Diptera, although, of course, without the trachea-like tubes so characteristic of the latter, and neither they nor the isolated palpus-like labium of the Earwig present any resemblance to the mouth-organs of either section of the Neuroptera.

The characters afforded by the wing venation, which were the basis of the original Linnæan classification, appear to me to indicate very forcibly the unity of the order. On Pl. I., at Figs. 3 and 4, I have figured the wings of *Calepteryx* and of *Sialis*, the whole of the inner or secondary nervures being omitted, in order to show the similarity of the principal nervures in these, the most diverse genera of the two sub-orders. The same main nervures may be traced without difficulty in *Libellula* and in *Chrysopa*, and

with less certainty in *Agrion*, *Hemerobius*, and other genera. In Fig. 5 of the same plate is shown the wing of *Agrion*, which, while remarkable for the rectangular shape of its cellules, presents in some portions, and particularly in the irregular-shaped cellules towards the lower margin, a distinct approach to the venation of *Chrysopa*, which has been given in previous figures. But a more curious feature is the manner in which the spaces between the longitudinal nervures are divided at the extremity of the wing, showing a relationship with the *Trichoptera*, in which such an arrangement is a distinctive feature and of a noticeable character.

The presence of the numerous fine short hairs upon the wing-veins of *Agrion* is also an indication of the affinity between this genus and the *Hemerobiidæ* and *Trichoptera*, in the latter of which the presence (in greater number) of similar short hairs upon the wings has given rise to the subordinal designation.

In concluding my remarks upon the wing structure, I would advise the student to examine for himself the various wings under a low-power objective, and to note the remarkable visual resemblance which is to be seen throughout the whole order—a resemblance which can be better realised by sight than by any amount of description or even of figures.

The last point which I shall consider is one on which much stress has been laid by some writers, but as to the value of which I feel considerable doubt in the present state of our knowledge. No doubt the evidence afforded by embryology has been of great value to biology and to comparative anatomy; but the difficulties which beset its practical application in the study of insects, are a serious obstacle to forming conclusions of definite value, based on such research alone. The embryological development of the genus *Calepteryx* has been exhaustively studied by Brandt, whose results are to be found in the *Memoirs of the Imperial Academy of Science at St. Petersburg*, and in the German work which he has published on the subject. With a view to compare the development of this genus of the *Odonata* with the same developments in one of the *Plannipennia*, I have studied the egg-development in *Chrysopa*, and have found it in the main to correspond with the account given by Brandt, though important differences appear as to the position of the embryo, both in relation to the egg itself and to the yolk-mass.

It is exceedingly difficult to observe in a satisfactory manner the earlier changes which take place within the eggs of *Chrysopa*. At an early stage, when the egg is broken under the microscope by pressure, the formation of nucleated cells may be seen to have commenced, and the first observation I have been able to make is the initial development of these for the formation of a blastoderm. Brandt describes the structure at this stage of a blastodermic envelope with some minuteness, and it appears to be identical with that of *Chrysopa*. Prior to this, round or ovoid nucleated cells are present in abundance, especially towards the lower end of the egg, and it seems, as might be expected, the formation proceeds by the subdivision of one or two of these cells, which are of a different character to the remainder. The primary germinative band floats rather freely on the surface of the yolk-mass. This is much as Brandt describes in *Calepteryx*, and to my own observation the development at this stage appears to be identical, and to differ considerably from the development in some eggs which I have examined, in which the band appears to be folded within the yolk-mass. Later, the band may be observed to turn inwards, as if about to penetrate the yolk.

After the formation of the blastoderm a change takes place by the separation of a layer, which seems to be the first indication of the formation of the viscera, and here the resemblance to *Calepteryx* is again manifest. But in the latter, at an early point, the germ so changes its position within the egg that the ultimate position of the head of the larva is remote from that originally occupied. It is not so in *Chrysopa*, in which the larval head remains in proximity to the microphyle throughout the development of the embryo. This important difference seems to me to detract greatly from the value of the otherwise similar embryological growth.

As the growth of the embryo proceeds, the extremity of the abdomen becomes recurved so as to enfold the lower end of the yolk-mass, and the head remains immediately below the microphyle. The first development of limbs and cephalic appendages is evident at an earlier stage, and during the remainder of the growth of the embryo it follows precisely the progress of the embryo of *Calepteryx*, as detailed and figured by Brandt.

I had hoped, when first examining these delicate changes, to find evidence of a definite nature as to the coincidence in the embryological growth of the two genera; but although the similarities are many and well marked, and are considered by Dr. Packard to be conclusive, I cannot altogether accept his view, on account of the change in position of the embryo, and I conclude that the evidence afforded by embryological examination is too doubtful to have much weight in the question of the relationship of the sub-orders of the *Neuroptera*. But although this point is left in doubt, the general habits and structure of the larvæ, the wing venation of the imagines, and the failure to find any really weighty indications of a relationship in any genera with either the *Orthoptera* on the one hand or the *Coleoptera* on the other, lead me to conclude that no sufficient ground has been shown for disturbing the Linnean arrangement of the order.

EXPLANATION OF PLATES I. AND II.

Plate I.

Fig. 1.—Imago of *Myrmeleon formicarius*.

,, 2.—Imago of *Calepteryx virgo*.

,, 3.—Principal nervures of wing in *Calepteryx*.

,, 4.—Same in wing of *Sialis lutaria*.

In these figures the lettering refers to the similar nervures in each, *a* being the cubital point; *bb* the anti-cubital transverse nervures; *dd* and *e* the radii; *c* is the costal nervure; *g* in Fig. 4 exhibits well the progress of the obliteration of a nervure, being often scarcely traceable through greater part of its length.

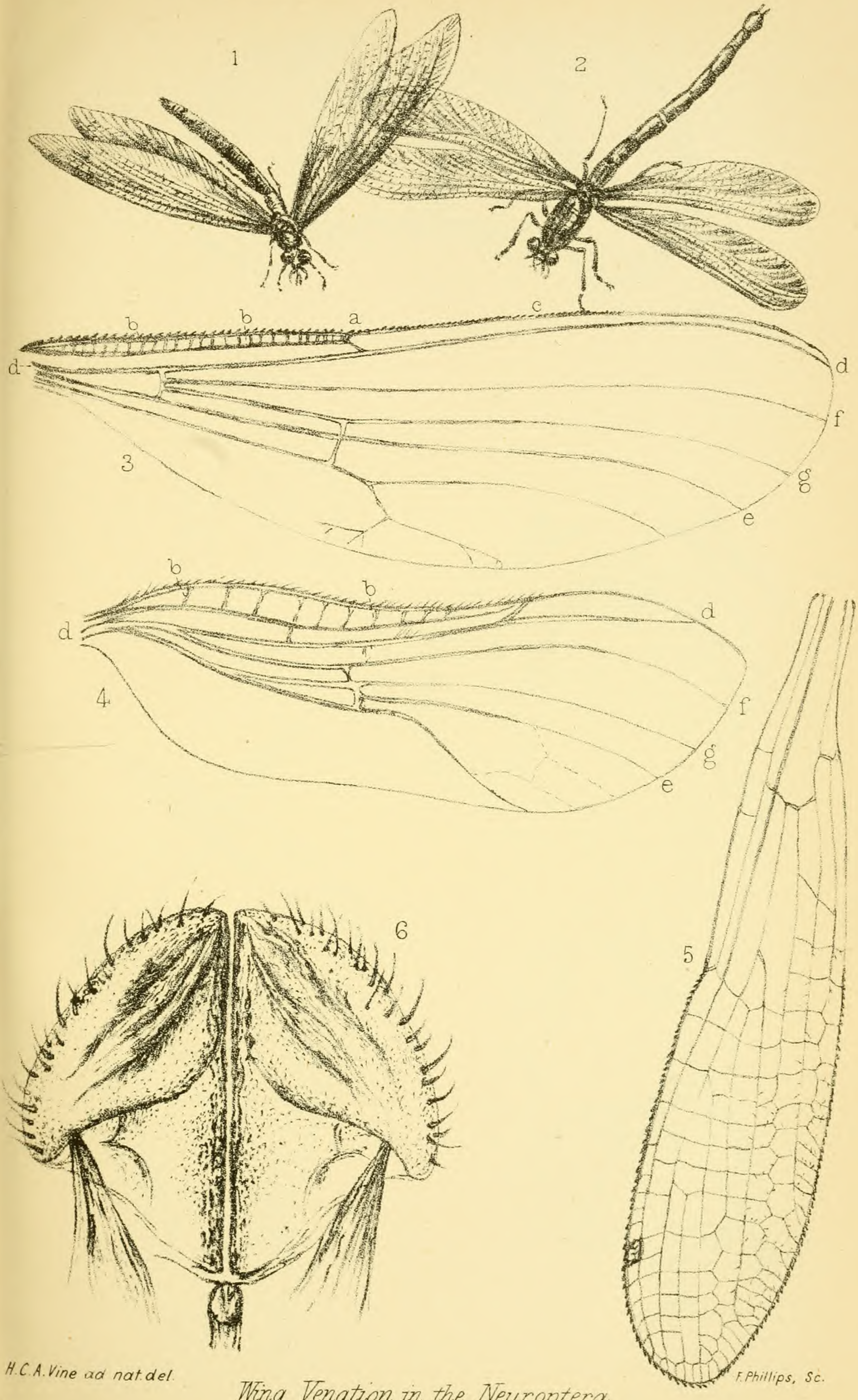
,, 5.—Wing venation of *Agrion puella*. This species exhibits an arrangement of the nervures in the main corresponding with that of the Odonata generally; but towards the lower edge the shape of the cellules and the short, sparse hairs show the relationship to the lacewings, while the structure towards the apex recalls distinctly the venation of the Trichoptera.

,, 6.—Labium of *Gryllus domesticus*, exhibiting the deep central division. It should be observed that this organ is of a fleshy character. The drawing is made from the upper or dorsal surface.

Plate II.

Fig. 1.—The labium and palpi of *Hemerobius*, seen from beneath.

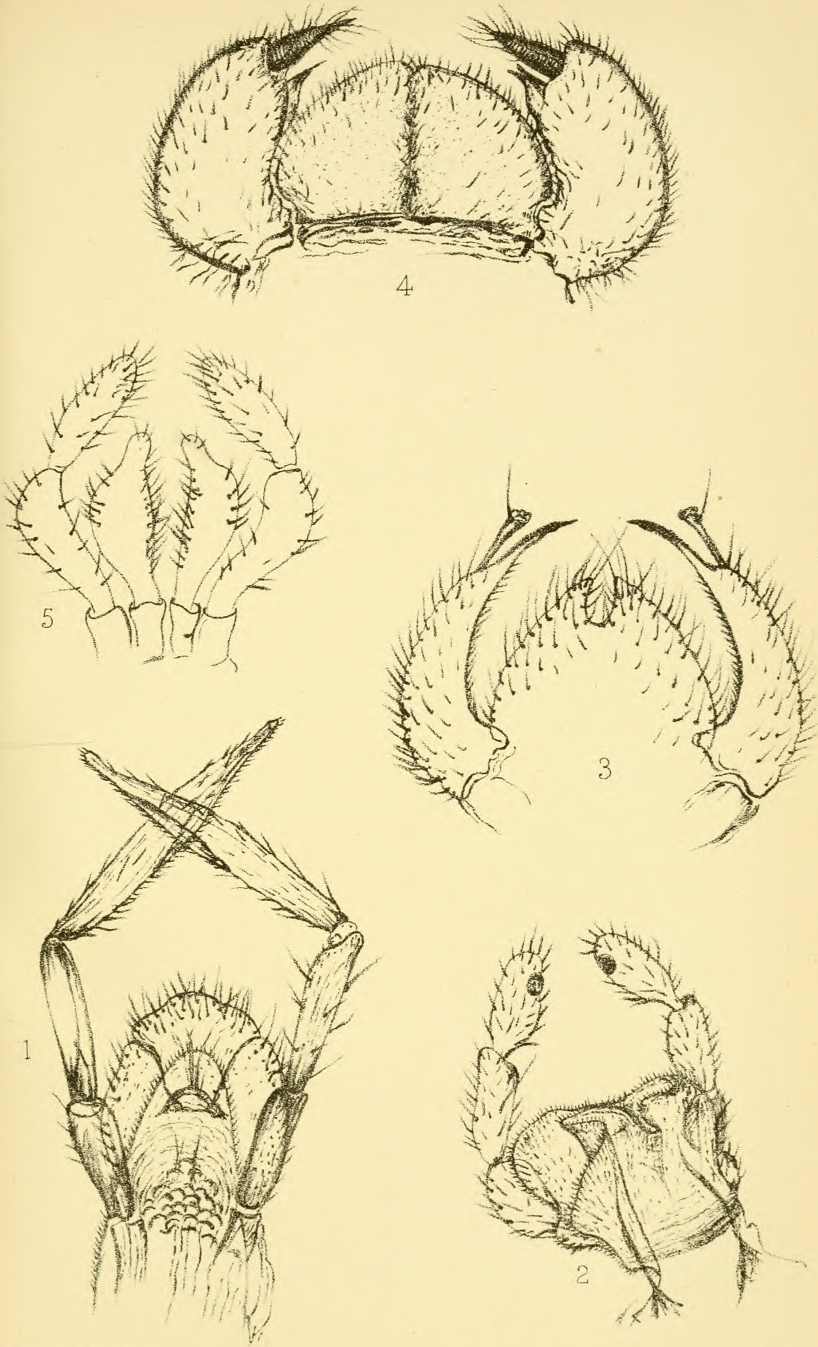
,, 2.—The same organs in *Sialis lutaria*, seen from above.



H.C.A. Vine ad nat. del.

F. Phillips, Sc.

Wing Venation in the Neuroptera
Labium of Gryllus Domesticus.



C. A. Vine, ad nat. del.

F. Phillips, Sc.

Structure of Labium in Neuroptera and Orthoptera.

Fig. 3.—The same organs in *Agrion puella.*

,, 4.—The same organs in *Libellula*, seen from beneath.

,, 5.—The same organs in the Earwig, *Forficula auricularia*, from beneath.

The figures display the relative characters of the Labium in the Neuroptera and the Orthoptera (see also Fig. 6 on Plate I).

Leaves from my Note-Book.

Gleanings from an Old Field.

BY ALICE BODINGTON, New Westminster, Canada.

IN the following paper, taken almost entirely from Darwin's *Animals and Plants under Domestication*, I have been able to choose only a few out of the innumerable interesting and important examples of natural and artificial selection given in that wonderful work. Indeed, the whole section dealing with variation in plants, and especially that part dealing with graft-hybrids, must be left for another paper.

Everyone has heard of the Ancon breed of sheep, arising from what (through our ignorance of its causes) is called a sport; but the Niata breed of cattle, which one cannot doubt must also have originated from a "sport" is not so well known.

CATTLE.

On the Northern bank of the Plata a strange breed of cattle has been developed known as "Niatas," and bearing much the same relation to other cattle as bull and pug dogs do to other dogs. The forehead is very short and broad, with the nasal end of the skull and the whole plane of the upper molar teeth curved upwards. The lower jaw projects beyond the upper, and has a corresponding curvature. An almost similar conformation characterises the gigantic extinct Sivatherium of India, but is not known in any other ruminant. The upper lip of the Niata is much drawn back, the nostrils are seated high up and are widely open, the eyes project outwards, and the horns are large. In walking the horns are carried low, and the neck is short. The exposed incisor teeth, short head, and up-

turned nostrils, give these cattle a most ludicrous, self-confident air of defiance. Many important anatomical variations occur in the skull; the lachrymal bone, for instance, articulates with the premaxillary, and thus excludes the maxillary from any junction with the nasal. In fact, hardly a bone of the skull presents the same exact shape as that of the common ox.

So far back as 1760 these cattle were kept as curiosities near Buenos Ayres, and the race was believed to have originated with the Indians southward of the Plata. In any case, however, the divergence of race could not have begun further back than the year 1552, when cattle were first introduced. The breed is very true, and has lasted at least a century (Darwin writes in 1868). A Niata bull and cow invariably produce Niata calves; a Niata bull crossed with a common cow and the reverse cross, yield offspring having an intermediate character, but with the Niata peculiarities strongly displayed.

When the pasture is tolerably long the Niatas feed as well as common cattle with their tongue and palate; but during the great droughts, when so many animals perish on the Pampos, the Niatas would, if not attended to, become extinct; for the common cattle, like horses, are able to keep alive by browsing with their lips on the twigs of trees and on reeds. This the Niatas cannot so well do, as their lips do not join, and hence they are found to perish before the common cattle. It shows also how natural selection would have determined the rejection of the Niata modification, if it had existed in a state of nature.*

Survival through Browsing on Twigs and Leaves.

Apropos of the faculty of keeping alive by browsing on leaves and twigs, a lady friend on a ranch in British Columbia told me they were waiting for a "wood cow." I wondered what particular kind of animal this might be, when she explained that cattle reared in a wooded district would thrive and even grow fat in the "bush," where prairie cattle would starve, On a ranch at Hatzic Prairie, the cattle accustomed to the country took to the woods during one severe winter, and in the spring returned in good condition, whilst the cattle which had remained on the prairie died in

* *Animals and Plants under Domestication*, Darwin, Vol. I., pp. 93-4.

numbers from want of food. The Cariboo (the Canadian Reindeer) flock to the shelter of the woods during the long winters of the Great North-West, and in the summer go to the shores of the Arctic Ocean in search of their favourite lichen, the "Iceland Moss"; and doubtless this instinct has enabled them to survive the extraordinary severe climatic conditions of this region.

Rabbits.

I will next give the account of the modifications, through the action of the fresh environments, of certain rabbits which were set loose on the Island of Porto Santo, near Madeira, in 1418, by J. Gonzales Zarco. Happening to have a female rabbit on board which had produced young during the voyage, he turned them all out on the island. The animals increased so rapidly that they actually caused the abandonment of the settlement. Thirty-seven years after, Cada Mosto described them as innumerable; nor is this surprising, as the island was not inhabited by any beast of prey, nor by any terrestrial mammal. At present, Porto Santo rabbits differ conspicuously from European wild rabbits both in colour and size. Whilst four wild English rabbits averaged 3 lbs. 5 ozs., one of the Porto Santo rabbits weighed only 1 lb 9 ozs. They have decreased nearly three inches in length and almost half in weight of body; whilst in the Zoological Gardens they had a remarkably different appearance to the common kind; they were extraordinarily wild and active, and many persons exclaimed on seeing them that they were more like large rats than rabbits. They were nocturnal to an unusual degree in their habits, and their wildness was never in the least subdued; so that Mr. Bartlett, the superintendent of the Zoo, declared that he had never had a wilder animal under his charge. This is a singular fact, considering that these rabbits must have descended from a domesticated breed.

On enquiry as to whether these animals had been much hunted by the inhabitants, or persecuted by hawks, or cats, etc., it appeared this was not the case, and that no cause could be assigned for their wildness. They live both on the central, higher rocky land, and near the sea cliffs, and being exceedingly timid, seldom appear in the lower and cultivated districts.

From numerous experiments carried on since *Animals and*

Plants under Variation was published, one may conclude that the small size of these rabbits results from great numbers depending on a scanty food supply. The necessity of looking out sharply for themselves also accounts for the fact that the brain capacity of the Porto Santo rabbits is very little less than that of the ordinary wild rabbit. In this respect the large lop-eared domestic breeds rank lowest; the skull in these animals has increased in length, but with a totally disproportionate weight of brain therein (see table, p. 133). Darwin concludes that most naturalists, on observing these Porto Santo rabbits with their reduced size, their fur, reddish above and grey beneath, their tails and ears not tipped with black, and above all the fact that they refused to couple with other rabbits, would have ranked them as a different species. Yet these differences certainly originated since the year 1420.*

Dogs.

It is well known that dogs which have relapsed into a feral state lose the habit of barking, this being a faculty apparently depending on the companionship of man and consequent stimulation of the dog's emotional and rational powers. Who that has been attached to a spaniel has not noticed the almost painful efforts these affectionate creatures make to express more feeling than can be got into a bark?

The Mackenzie River dogs of the *Canis latrans* type, when brought to England, never learnt to bark properly; but one born in the Zoo "made his voice sound as loudly as any other dog of the same age and size." Not only is the habit of barking quickly regained by dogs which have lost that habit in the feral (relapsed) state, but there is evidence that it can be acquired by both wolf and jackal whelps in one generation.†

Some dogs which had run wild on Juan de Nova in the Indian Ocean, entirely lost the faculty of barking, showed no inclination for the company of other dogs, and did not acquire their voice during a captivity of several months. On the island they congregate in vast packs, and catch sea-birds with as much address as foxes could display. In New Guinea and Tierra del Fuego the

* *Ibid.*, 117—20, Table of skull and brain measurements, p. 113.

† *Ibid.*, pp. 27—8.

dogs show a ready adaptation to circumstances by catching crabs and fish in the tidal pools in the rocky coast. They will turn over the stones on the shore to catch the crustaceans which lie beneath, and "are clever enough to knock off the shell-fish at a first blow," for if this be not done shell-fish are well known to have an almost invincible power of adhesion.*

Alteration of Mental and Physical Characteristics by Climate.

In India the climate directly modifies the forms of dogs, and even their mental and moral qualities. Several of our English breeds cannot live in India, and it is positively stated that when bred there they degenerate, not only in their mental faculties, but in form. Captain Williamson, who carefully attended to this subject, states that "hounds are the most rapid in their decline; greyhounds and pointers also rapidly decline." Dr. Falconer states that bulldogs which have been known, when first brought into the country, to pin down even an elephant by its trunk, not only fall off in two or three generations in pluck and ferocity, but lose the underhung character of their lower jaws; their muzzles become finer, and their bodies lighter. The Rev. R. Everest obtained a pair of setters born in India, which perfectly resembled their Scotch parents; he raised several litters from them in Delhi, taking most stringent precautions to prevent a cross; but he never succeeded, though this was only the second generation in India, in obtaining a single young dog like its parents in size and make; their nostrils were more contracted, their noses more pointed, their size inferior, and their limbs more slender.

Degenerative changes even more pronounced are mentioned as occurring in dogs on the coast of Guinea. According to Bosman, "they alter strangely; their ears grow long and stiff like those of foxes, to which colour they also incline; so that in three or four years they degenerate into very ugly creatures; and in three or four broods their barking changes into a howl.†

I will just mention, before leaving the subject of the dog, the curious case of a mental quality remaining where outward physical

* p. 41.

† *Ibid.*, pp. 39—4.

characteristics have disappeared. Lord Orford, as is well known, crossed his famous greyhounds, which failed in courage with a bulldog; and "after the sixth or seventh generation," says Youatt, "there was not a vestige left of the form of the bulldog, but his courage and indomitable perseverance remained." This inheritance of mental qualities is perhaps not so extraordinary in an animal which shows itself capable of such development of brain as does the dog. "Some dogs' brains are high and rounded," says Dr. Burt Wilder, "whilst others are long, low, and narrow in front. In the latter the olfactory lobes are visible for about half their extent, when the brain is seen from above, but *they are wholly concealed by the hemispheres* in other breeds.*

Ducks.†

The duck has been comparatively a late arrival amongst domesticated auimals; it was not known to the ancient Egyptians, the Jews of the Old Testament, or the Greeks of the Homeric period; indeed, the tame duck was not known to Aristotle. About eighteen centuries ago, Columella and Varro speak of the necessity of keeping ducks in netted enclosures like other wild fowl, so that even at this period there was danger of them flying away. As Columella advises those persons who wish to increase their stock of ducks to collect the eggs of wild birds and place them under a hen, it is evident that the duck had not yet become a naturalised and prolific inmate of the Roman poultry yard.

An interesting experiment was made by Mr. Hewitt in trying the effect of domestication on the wild duck.‡ His experience differed from that of Tiburtius in Sweden, who, after rearing wild ducks for three generations, found they did not vary even in a single feather. Mr. Hewitt, on the contrary, found that his young birds always changed and deteriorated in character in the course of two or three generations, notwithstanding that great care was taken to prevent them from crossing with tame ducks. After the third generation his birds lost the elegant carriage of the wild species, and began to acquire the gait of the common duck. The

* *Ibid.*, p 35.

† pp. 291—93.

‡ *Journal of Horticulture*, 1862, p. 773, and 1863. p. 39.

white collar round the neck of the mallard became broader and less regular, and some of the long primary wing feathers became more or less white. When this occurred, Mr. Hewitt destroyed nearly the whole of his stock, and procured fresh eggs from wild nests; so that he never bred from the same family for more than five or six generations. It seems strange that he was not curious to see the further result of his experiment. His birds continued to pair together, and never became polygamous, like the common domestic duck. I presume that the expression "deterioration" must be meant to apply to the profound mental and moral deterioration of the domesticated duck, since Mr. Hewitt's semi-tamed wild ducks increased in size. Woefully has civilisation changed the habits of the tame duck from this idyllic picture of its wild cousins.

"The Wild Duck pairs very early in the year, the period being somewhat delayed by hard weather and the ceremonies of courtship, which require some little time. Soon after these are performed the respective couples separate in search of suitable nesting places. The spot chosen is often near a river or pond, but often very far removed from water; and it may be under a furze bush or a dry heath, at the bottom of a thick hedge-row, or even in any convenient hole in a tree. A little dry grass is generally collected, and on it the eggs, from nine to eleven in number, are laid. As soon as she begins to sit, the mother begins to divest herself of the down which grows thickly beneath her breast feathers, so that the eggs are deeply embedded in this heat-retaining substance—a portion of which she is always careful to pull, as a coverlet, over her treasures when she quits them for food. She is seldom absent from the nest but once, or perhaps twice, a day, and then she dare not leave it till her mate has assured her she may do so unobserved. Joining him, the pair resort to some quiet spot, where she may bathe and otherwise refresh herself. Then they return to the nest, and after cautiously reconnoitring the neighbourhood, she reseats herself on her eggs, while her mate, when she is settled, repairs again to the water, and passes his time listlessly in the company of his brethren, who have the same duties, hopes, and cares. Short and infrequent as are the absences of the duck during incubation, they become shorter and more infrequent

towards its close, and for the last day or two it is probable that she will not stir from the nest at all. When the eggs are hatched, her next care is to get her brood safely to the water. This, when the distance is considerable, necessarily demands great caution, and so cunningly is it done that but few persons have encountered the mother and offspring as they make the dangerous journey. (When Ducks breed in trees, as is often the case in the London parks, it is still a mystery how the young are conveyed to the ground.) If disturbed, the young immediately hide as they best can, while the mother quacks loudly, feigns lameness, and flutters off to divert the attention of intruders from the brood, who lie motionless at her warning notes. Throughout the summer the Duck continues her care unremittingly, until her young are full grown and feathered."*

The deterioration of instinct brought about by civilisation is often painful to witness. Not only is the instinct of nest-making lost, but the eggs are dropped in any place where the bird may happen to be; in the dust of the poultry yard, or in a pond. Persons who wish to rear ducks profitably are therefore accustomed to shut them up in their pens till after laying. One duck I had hatched some young ones on her own account, but the maternal instinct, except for sitting, was dead; she deserted her young ones, which endeavoured wearily to follow her, and when they were placed in a coop with her she endeavoured to kill them. But most of the ducks I had did not attempt even to sit. In one duck, who from a remote resemblance to the Aylesbury breed was known as the Marchioness, maternal instinct by a species of atavism was healthy. Year after year the Marchioness made her nest where none of us could even find it, and came in followed by a brood of five young ducks, which she watched over with the fiercest vigilance.

Call Ducks.

Darwin, speaking of the Call Duck, gives an instance of transmission of a quality peculiar to the female of this variety, through the male. He says, "Call Ducks are remarkable for their extraordinary loquacity: the drake only hisses like common drakes;

* Article Duck, *Encyclopædia Britannica.*

nevertheless, when paired with the common duck, he transmits to his female offspring a strong quacking tendency." *

Correlation of Growth.

Speaking of the correlation of variations, Darwin describes, at great length, the extraordinary osteological changes in the skulls of crested fowls; beginning in the black boned silk fowl with a very small crest, and the skull penetrated only by a few minute orifices; and culminating in fowls which, with a largely developed crest, have a largely protuberant skull, perforated by a multitude of irregular open spaces, and containing a portion of the brain substance. He adds, "There can be no doubt that in former times the breeders of Polish fowls attended solely to the crest, and not to the skull; nevertheless, by increasing the crest, he has unintentionally made the skull prominent to an astonishing degree; and, through correlation of growth, he has, at the same time, affected the form and relative connection of the premaxillary and nasal bones, the shape of the orifice of the nose, the breadth of the frontal bones, the shape of the post-lateral processes on the frontal and squamosal bones, the direction of the axis of the long cavity of the ear, and lastly, the internal configuration of the whole skull, together with the shape of the brain."

Darwin gives numerous instances of breeds of animals and varieties of plants originating from "sports," and uses the expression that the variations "arose suddenly." Paleontology leads one to infer that differentiation of species has arisen by slow and almost imperceptible degrees, and this seems to be the usual course of evolution; but, on the other hand, we have a great weight of first-hand evidence as to the origination of fresh breeds by sudden variations.

I will take one case, that of the Black Peacock. Sir R. Heron states that this breed suddenly appeared, within his memory, in Lord Brownlow's large stock of pied, white, and common peacocks, and in Mr. Thornton's stock of common and pied peacocks. It is remarkable that in these two latter instances the black-shouldered kind, though a smaller and weaker bird, increased "to the extinction of the previously existing breed." No less than seven well

* Vol. I., pp. 295—6. *Ibid.*, p. 279.

authenticated cases have occurred in Great Britain of japanned birds having suddenly appeared, within recent times, in flocks of the common peacock. Mr. Sclater, a high authority, imagined that these black peacocks were a reversion to some breed which would hereafter be discovered in a wild state; but as no wild birds of this description have ever been found, we may consider these japanned peacocks demonstrate one of nature's ways of producing a new species.*

The constitutional strength of the young japanned peacocks, which led to the extinction of the lighter varieties, is parallelled in many other instances by the increased constitutional strength of many other dark animals. Professor Wyman informed Darwin that "being surprised to find all the Pigs in one part of Virginia black, he made enquiries, and ascertained that these animals fed on the roots of the *Lachnanthes tinctoria*, which colours their bones pink, and, excepting in the case of the black varieties, causes their hoofs to drop off." The squatters therefore chose only black pigs out of a litter for raising, as they alone had a good chance of living. In the Tarentino the inhabitants keep black sheep alone, because the *Hypericum crispum* abounds there, and this plant does not injure black sheep, but kills the white ones in about a fortnight's time. And similar deep constitutional differences, with regard to susceptibility to certain diseases, is found in the dark and light varieties of man.

Throughout the two volumes of *Animals and Plants under Domestication*, one sees it was Darwtn's task to prove, by overwhelming cumulative evidence, that an accumulation of variations under natural or artificial selection could lead to the formation of new species. His work was not to examine *how* variations arise; but this still deeply mysterious question is the one of chief importance to the present generation, to whom the fact of the evolution of species, which Darwin laboured to establish, is a truism.

I have had room to give only a very few of the wealth of interesting facts in this wonderful work of Darwin; and I must leave the evidence as to Graft-Hybrids, perhaps at this day the most interesting and important of all, for another paper.

* *Ibid.*, pp. 305—6, Vol. II., p. 212, 329—31.

British Hydrachnidæ, III.

By Charles D. Soar. Pl. III.

THE GENUS HYDRACHNA (O. F. Müller, 1781).

BODY, nearly circular in shape, soft and easily broken; legs, short, hairy, and adapted for swimming; all the tarsi have claws; epimera forms two groups on each side; mandibles joined together, forming a beak, which under the microscope can be seen to be lancet-shaped; palpi, tolerably long, the third joint being the longest.

Müller, in his work on *Water-Mites*, published in 1781, describes and figures forty-nine species of *Hydrachna*, using a specific name only to distinguish one form from another. Since then the family of *Hydrachnidæ* has been divided into twenty distinct genera, the name *Hydrachna* being retained for the genus we are now considering, the characteristics of which are given above. Dugès was, I believe, the first to restrict this genus to those mites possessing a beak. Koch, in his work, *Deutschlands Crust.*, etc., describes and figures five species, viz.:—*H. geographica*, *H. impressa*, *H. globosa*, *H. cruenta*, and *H. punicea*. Neuman describes only two.

I have not yet had an opportunity of observing the transition of any of these from the egg to the imago; but it has been observed and described by other writers. The eggs are laid in the spring on the stems and leaves of aquatic plants; in a few days these are hatched out. The larvæ when hatched are hexapod, with a large heart-shaped sucker in front, which might be taken for the head; but the eyes are situated behind on the anterior margin of the body. In this stage they attach themselves to different species of water insects, such as *Nepa*, *Dytiscus marginalis*, etc.

Several times in the pages of the earlier volumes of *Science Gossip* may be found the query, What are the blood-red, pear-shaped parasites firmly attached to the under part of the head of the male *Dytiscus*? On page 255 of *Science Gossip*, Vol. I., Lewis G. Mills gives a figure of one found by him, which is no doubt the larval form of a species of *Hydrachna*. After having spent a certain time as a parasite on some other living object, they no

doubt turn into the perfect mite. A short time ago a Quekett man was surprised to find, on examining a *Dytiscus marginalis* which he had preserved in spirit some time before, a perfect mite (genus *Hydrachna*), partly emerged from the body of the beetle. As I have not seen it, I cannot say what species it was. I am inclined to think that, when this subject has been more studied, the same species of mite will always be found on the same species of water insect. As a typical species of *Hydrachna*, I propose to describe and illustrate *Hydrachna geographica* (Müller).

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1793.—*Trombidium geographicum.* J. C. Fabricius, *Ent. Syst.*, Tom. II., p. 405, N. 32.

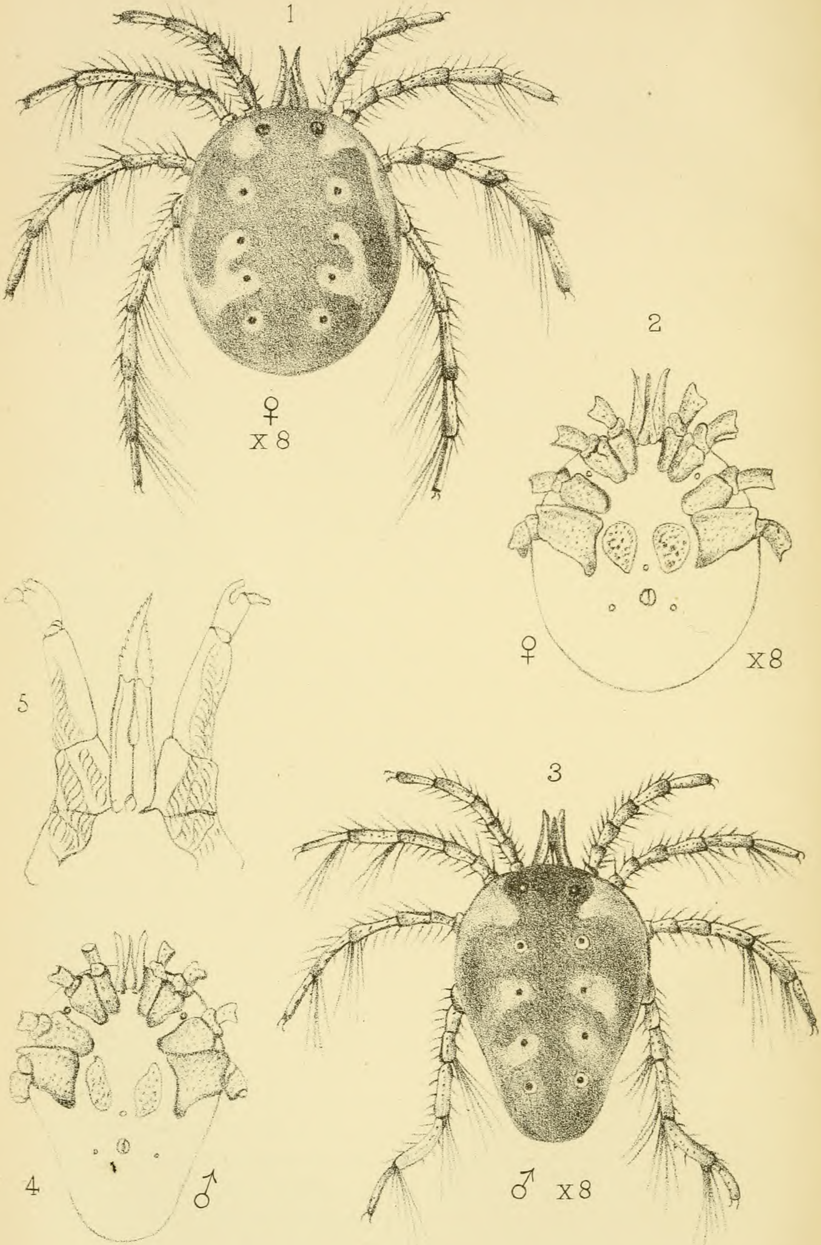
1835-41.—*Hydrachna geographica.* C. L. Koch, *Deutschlands Crust.*, etc., Haft. 14, Fig. 13.

1879.—*Hydrachna geographica.* Neuman, *Sveriges Hydrachnider*, p. 111, Tab. xiv., Fig. 2.

This species is, I believe, the largest of the water mites, specimens having been found measuring as much as one-third of an inch in length.

The female from which this drawing was made is about one-fifth of an inch long. Body nearly circular, black and red in colour. On the dorsal side are eight spots, or pores, arranged in two rows, as shown in the drawing. Legs red, with yellow joints. In some drawings which I have seen of this mite, the legs are shown as black with red joints; but those which I have examined have not been so. The first pair of legs are without swimming-hairs. It is a very beautiful mite alive, and is a powerful swimmer.

The male is pear-shaped, and a little smaller than the female. I have not at present been able to detect any difference in the sexes. The male of *H. geographica* has not the peculiar process on the fourth pair of legs nor the modified third pair of feet met with in males of other species of *Hydrachna*, as described in the previous papers on this subject. Both these mites were taken by me at Snaresbrook on March 23rd, 1895, on one of the excursions of the Quekett Microscopical Club. I believe this is the first time the male has been figured.



C. D. Soar, ad nat. del.

F. Phillips, Sc.

Hydrachna geographica.

EXPLANATION OF PLATE III.

Fig. 1.—Dorsal view of female.
,, 2.—Ventral view ,,
,, 3.—Dorsal view of male.
,, 4.—Ventral view ,,
,, 5.—Palpi and mandibles.

The Origin of Insect Transformations.

By G. H. Bryan, M.A., F.R.S.

At the Ipswich meeting of the British Association, Prof. C. L. Miall, F.R.S., of the Yorkshire College, Leeds, read a most interesting paper on this subject, and it has occurred to me that a brief account of Prof. Miall's views might be acceptable to the readers of the *Journal of Microscopy*.

The subject was dealt with twenty-one years ago by Sir John Lubbock in his well-known little book, published in the *Nature* series; but since the appearance of that work many new facts have been discovered which necessitate some modifications of the conclusions then arrived at by him.

The primary object from which all animal metamorphoses owe their origin is the facilitation of dispersal, and at one time it was thought that some analogy existed between the transformations of insects and those of many marine animals, such as the Echinodermata and the Common Limpet. Prof. Miall considers the two classes of transformations to be radically different in their nature.

It will be noticed that both transformations result from a division of labour in the two operations of feeding and dispersal, but in the marine animals dispersal takes place first, and feeding second; while the insects feed in their early stages and only become adapted to dispersal in their final stage. For this reason, the transformations of the Echinodermata may be called Larval Transformations, since they take place before the animal has grown and developed, while those of the insects may be distinguished as Adult Transformations. A closer parallel to insect transformations exists in the amphibia. Thus, in the tadpole

stage of the common frog, the animal grows and developes, while it is not till the final stage that it becomes adapted for migrating from one pond to another.

In the birds we have an instance in which the operations of feeding and dispersal are performed simultaneously, and consequently no metamorphoses are required.

The reason for the peculiar transformations of the marine animals can be traced to the conditions under which they live. In the ovum, the yolk is scanty by reason of the great number of eggs produced; and this, again, is necessitated by the extraordinary risks to which the animals are liable, especially where the sea is shallow. Another cause consists in the heavy armour with which the adult Echinodermata are protected and which would render migration impossible, or at any rate very difficult. Again, marine animals are more easily dispersed by currents when they are small; consequently, the means of locomotion are eminently suitable for an animal in its early incomplete stages.

In the insects it is just the reverse. The mechanical difficulties connected with the operation of flying can only be overcome by an animal in its mature stage, and the same thing applies to the amphibia, which for the purposes of dispersal require to be capable of locomotion both on land and in water, a combination which is naturally most easy of attainment in the mature state. Thus, the operation of migration is naturally performed by the adult animal and that of feeding by the larva, The result of this division of labour is to cause the larva to degenerate. In proportion as the adult becomes more and more highly developed, the larva sinks lower and lower and loses its active organs, until we come to larvæ which consist of little more than a soft, flabby sac, furnished with jaws, or, going still further down in the scale, we find that in the larva of the blow-fly even these jaws are replaced by mere hooks.

The type of the primitive insect, according to Fritz Müller, was very much like some of the present wingless orthoptera. According to Brauer and Lubbock, the nearest modern approach to the ancestral type is represented by *Campodea*. The larvæ of certain carnivorous beetles are very similar to this type. Regarding the wings of primitive insects, it is remarkable that many insects in

the embryo stage show traces of three pairs of wings as well as three pairs of legs, and it therefore seems probable that the front pair were not retained because they were too far away from the insect's centre of gravity. The breathing trumpet of the pupa of the gnat is probably a modified form of these appendages. In certain fossil insects these "prothoracic wings are well developed," and according to Broginart this is notably the case in certain palæozoic insects from the Coal Measures.

The pupal stage of insects is unique, and has no parallel in any other division of the animal kingdom. It has been suggested that the necessity for this stage originated in the changes which the mouth parts undergo. This explanation is insufficient, because many insects which pass through a quiescent pupal stage do not change their food in passing from the larval to the imago stage. Sir John Lubbock has suggested that the pupal stage is a consequence of the immature condition of the larva at the time of its birth; and Brauer has pointed out in confirmation of this theory that insects which have large eggs are not generally quiescent as pupæ. But there are exceptions to this rule; moreover, the pupa is too remote from the larval stage for the conditions at its time of birth to have much influence on it then. Again, in many cases, the larva in the egg positively retrogrades, so that at the time of hatching it has degenerated from its form in the earlier stages of the egg.

A more likely explanation is that pupation is a consequence of this very degeneration of the larva. As the imago developes, the larva degenerates, and extremes thus recede until a resting stage is required for the regeneration of the insect. Thus, the blow-fly is a highly-developed insect, but its larva is little more than a digestive sac, furnished with hooks, which, as above mentioned, take the place of proper jaws.

The divergence between the larva and imago state is in many insects doubtless partly due to their honey-sucking habits. Of all insects, the bees have been the most influenced in this respect by flowers; lepidoptera come next; and many diptera are also honey-suckers. Not only have insects played a prominent part in the development of flowers, but the juices of flowers have formed an important article of food to insects, the more so as honey can be

stored without undergoing putrefaction. This storage of honey has caused further degeneration, which has cost the larva of the bee its legs; these, being no longer required to enable it to reach its food, have disappeared.

Ants form a remarkable exception among the hymenoptera in the matter of gathering honey, but even they show the same propensity for sweet juices in a slightly different form, in their habit of keeping aphides as cows from which they suck the honeydew,

The suddenness of the change from larva to pupa and from pupa to imago is probably caused by the hard integument of many insects, which does not admit of gradual changes taking place. A sudden change has thus taken place at the time of moulting, and with the gradual divergence between the larval and imago states this change has become more marked, and has necessitated the intervention of a quiescent pupal stage. A notable exception occurs in *Meloë*, which in its first stage is active, and subsequently becomes more like a maggot.

To sum up, then, the separation of the functions of nutrition and locomotion has caused insects to become more highly developed in their final stage and to degenerate in their early stage. The hardness of their integument has necessitated the transformations taking place at the times of moulting, and the difference between the larva and imago has at last become so marked that the intervention of a quiescent pupal stage has become the only possible means of bridging over the gap.

GROWTH OF TREES.—The following interesting results of experiments relating to the growth of trees at various times of the day have been sent to us by Mr. E. H. Thompson, the Government Entomologist of Tasmania. Measurements were taken as far as possible every three hours, with the following results:—From 6 a.m. to 9 a.m., $8\frac{3}{8}$ per cent. of growth; from 9 a.m. to noon, $1\frac{1}{8}$ per cent. of growth; from noon to 3 p.m., no growth; from 3 p.m. to 6 p.m., no growth; from 6 p.m. to 9 p.m., $1\frac{1}{8}$ per cent. of growth; from 9 p.m. to 12 p.m., $3\frac{7}{8}$ per cent. of growth; from 12 p.m. to 6 a.m., 85 per cent. of growth. The greatest growths in twenty-four hours were:—Banksia Rose, $6\frac{1}{2}$ in.; Geranium, $5\frac{3}{4}$ in.; Wattle, $4\frac{1}{3}$ in.; Apple, $2\frac{1}{4}$ in.; and Pear, $1\frac{1}{8}$ in.—*Public Opinion.*

Some Adaptation of Water Plants to their Environment.

By W. Falconer.

WATER plays such an all-important part in the growth and economy of every organism that no surprise is felt either at the abundance or variety of vegetable life found in moist situations; and when we note the habitats selected by the various plants, the banks clothed with flowers, grasses, and sedges in tangled confusion, the shallow waters of the edge in which grow many familiar floral types, and the deeper central waters in which other forms flourish, and note, also, the conditions under which they grow, so diverse and so different to those which obtain in the case of land-plants, one naturally expects much differentiation of structure due to environment, and the acquisition of new habits to meet the altered circumstances under which each must perfect its seed, reproduce its kind, and obtain the air and light necessary to a healthy and continued existence. Nor is our expectation disappointed, and in pursuing our inquiries into the subject it becomes a matter of some difficulty to select from the wealth of material at our disposal typical exemplifications of the now accepted principles of scientific investigation, inaugurated by Darwin and Wallace. I propose, within the limits of the space allotted to this paper, to deal with a few characteristic adaptations of water-plants to their surroundings which are of general interest.

I.—We observe in them a deficiency as well as a different arrangement of the strengthening or woody tissue, which gives mechanical support to stems and other structures. In a land-plant, the bundles of this material are arranged towards the periphery of the stem, in which position they are most advantageously disposed to withstand the varied and constant strains to which they are exposed, and which are mainly lateral, arising chiefly from the action of winds which blow in a lateral direction. The organism has, by this provision of nature, sufficient strength in itself to endure the strife of the elements, and so escapes destruction. By way of illustration, and from the point of view of an engineer, we might compare the plant to the cylindrical iron sup-

porting pillar of a bridge, which, in accordance with well-known mechanical principles, is hollowed in order to throw all the strength to the outside, the better to resist any lateral strain, and which may be filled with cement in order to sustain a more crushing weight. But from the very nature of its environment, a hydrophyte is protected from winds, and hence from lateral strains. Its parts float freely, and rise and fall with the waters or move hither and thither in obedience to currents. The only force, therefore, that can be brought to bear upon the plant in this situation is a pulling one. In still water, where there are no currents, and the only turmoil is that temporarily caused by the movement of some animal organism or by the breeze, the innate recuperative power and cohesive force of the cell-walls of the freely floating portions is sufficient protection for the plant; but in running water something more than this is needed, and the tissues become flexible and tougher and their walls thickened.

In any case as compared with land-plants, the bundles become fewer in number, and have a tendency to assume an axial position (see T.S. of Villarsia), Neither do the component cells become lignified to the same extent, as the absence of any great strain relieves the plant from the necessity of making what would, under the circumstances, be useless tissue. As a further illustration of the mechanical importance of the central grouping of the fibrovascular bundles, take the analogous case of a root. A root, apart from the pressure exerted by the superincumbent soil, is liable only to the pulling or longitudinal strain caused by the bending and swaying of the stem, in these respects resembling a hydrophyte. The strain to be resisted, however, is very much greater, and the structural arrangement best adapted to meet it is the central grouping of the resisting forces, as has been proved in practice by man, who uses the same means to obtain the same ends. Under parallel circumstances, the aquatic stem and a root develop an approximately similar structure, so far, at least, as the grouping of the bundles is concerned.

In addition to the adaptation just mentioned, water-plants have, in various parts of their other tissues, in leaf and stem and petiole, numerous air-spaces which are not to be confounded with similar cavities in the hollow stems of *Equisetum* grasses and *Umbelliferæ.*

In the latter, they are produced by the drying-up of masses of tissue, as is shown by ragged edges of cell-walls remaining after the drying-up process; and in the former, by the clean separation of the walls dividing cells, such fringes being absent. These air-spaces, which, when the plant is in a healthy state, are filled with a mixture of gases, practically the same as atmospheric air, and from which it may obtain supplies of carbonic acid, buoy up aquatic plants in the water, and effectually secure mechanical support to them, so that, after all, the non-lignification of cells is really an advantage to such organisms, owing to the greater lightness thus obtained by the reduction of the strengthening strands. This altered structural formation is more clearly shown in those plants which are totally submerged. For example, *Anacharis*, *Hottonia palustris*, and *Utricularia* are much more thoroughly aquatic types than *Hippuris*, *Nuphar luteum*, and *Nymphæa alba*. French *savants* have experimented with normally terrestrial plants, growing them in water, and in doing so have educed another proof of the great influence of environment on plant tissues. Under these circumstances, any new growths were found to assume the aquatic type of structure.

II.—A plant obtains its chief food, carbon, from a gas, carbon dioxide (a compound of carbon) and oxygen, which is present in the air, being provided with little mouths or stomata, through which the gas has access to the internal tissues, where the chlorophyll or green colouring matter of the cells, in the presence of water, decomposes it, fixing the carbon and restoring the oxygen to the atmosphere. Many of the vital operations in the plant's economy—such as the decomposition of the carbon dioxide and the expulsion of the oxygen already mentioned, the formation of chlorophyll, and the transmutation of the crude sap and the carbon into food material for the plant—can only be carried on under the influence of light.

It is not, therefore, difficult to comprehend that a plant or a portion of a plant, growing immersed, must undergo modifications of structure to enable it, under the changed conditions of its life, to get its due share of light and air. The submerged leaves, accordingly, become much divided, in order to allow a ready passage to rays of light, and to enable the plant to extend its

operations through a greater area of the fluid from which it derives its supplies of carbon dioxide, as in *Ranunculus aquatilis*, *Hottonia*, *Utricularia*, and *Myriophyllum*. In other plants whose submerged leaves approach in size and shape the terrestrial type, as in *Anacharis*, *Potamogeton crispus*, *P. densus*, and *P. perfoliatus*, the same ends are subserved by the translucency of these organs, together with their comparative smallness and greater number. Moreover, many of them grow in slow-running streams, and their flexible stems permit them to assume a sloping position, so that the upper leaves shut out little or no light from the lower ones. Submerged leaves have no stomata, the carbon dioxide which they require for food being absorbed directly from and with the surrounding water, or in combination with calcium as bicarbonate of lime, the latter salt being in solution and having a higher percentage composition of its component carbonic acid than monocarbonate of lime ($CaCo_3$), from which it has been formed. A number of hydrophytes, including *Myriophyllum*, *Ceratophyllum*, *Ranunculus aquatilis*, and several species of pondweeds, are capable of absorbing from the bicarbonate this extra portion of carbonic acid, leaving the nearly insoluble (in water) monocarbonate as an incrustation on the stems and leaves.

In some cases, the lime, in addition to forming in this way an external coating to the cell-wall, permeates its substance as well. Apart from its geological importance as a factor in the formation of calcareous beds, consequent on the death and decay of a succession of such vegetable growths, the precipitated lime acts as a further protection to the tender tissues of the living plants. Floating leaves are, as a rule, entire (*e.g.*, *Nymphæa*, *Nuphar*, *Villarsia*, *Hydrocharis*), and have no stomata on their lower surface, where they are in contact with the fluid, but have abundance on the upper surface, which is exposed to the air.

Aërial leaves, which are lifted entirely out of the water, are usually erect, and have the stomata pretty equally distributed on both surfaces (water-flag, grasses, and sedges). The water buttercup (*Ranunculus aquatilis*), already cited as an example, strikingly illustrates the various types of leaves characteristic of aquatic plants. Some varieties of it have all the leaves submerged and all finely divided ; others have both submerged and floating leaves,

the submerged again being finely divided and the floating ones entire; while on mud the plant produces only entire leaves.

III.—When we make a comprehensive survey of the various genera and species of aquatic plants, we find that the greater number of them have only their lower parts immersed in water (*Nymphæa*, *Nuphar*, various *Umbelliferæ*, *Alisma*, *Sparganium*, *Typha*, etc.), while comparatively few are totally submerged (*Ruppa*, various *Potamogetons*, *Myriophyllum*, *Anacharis*), and fewer still float freely without attachment. The first cannot live if wholly immersed for any length of time, and the two last if they are removed from the watery medium which surrounds them and exposed to the air.

The unattached plants usually grow in quiet pools and ditches, and are therefore not subject to any great displacement. Some of them (*Lemna polyrhiza*, *L. gibba*, *L. minor*) possess roots, and others (*Lemna trisulca*, *Ceratophyllum*, *Utricularia*, *Hottonia*) none at all. Those provided with roots, when left on moist earth, can still exist, being capable of absorbing food from the ground by these appendages in the same manner as a land-plant, but, under the same adverse conditions, the less perfectly equipped rootless plants perish.

Some of the partially immersed plants (reeds, rushes, water-lilies) may have their submerged parts bared by the retreating water without injury, as they will continue to thrive just as well on the wet earth, their leaves being adapted to live an aërial life. In others (*Potamogeton natans*, *P. heterophyllus*, *Ranunculus aquatilis*) which have both submerged and floating leaves, when thus stranded, the submerged leaves alone decay, as their structure renders them incapable of absorbing carbon-dioxide from the atmosphere itself, but the floating leaves continue to thrive, and any new leaves produced conform to the shape of the hitherto floating ones.

The cause of these phenomena is to be looked for in the structural differences of the parts. The cellulose, the substance of which the cell-wall largely consists, becomes in the aërial portions of plants corky, very elastic, and nearly impermeable to water, or cuticularised, as it is termed. This modified cellulose is highly important to the plant, as it prevents excessive loss of water by evaporation through the cell-wall. In hydrophytes, the epider-

mis is not differentiated in this manner, as there is no danger to them, by very reason of their environment, of any loss of the precious fluid; but as the latter, with its contained food-salts, enters them through their whole surface, it is necessary for their epidermis to have absorptive powers. Consequently, there is no thickening or cuticularisation of the submerged external walls, the cells are conterminous everywhere, leaving no openings and forming an excellent absorptive surface, no organs being needed either for the conduction or transpiration of water.

The amount of transpiration also varies with the temperature and climate. In very hot countries where the loss of water by evaporation is correspondingly great, the cuticle is markedly evident, consisting of several layers of cells, this formation being well seen in *Ficus elastica*, the India-rubber plant. In plants growing in temperate regions in damp places, the quantity of this tissue is considerably less, and where it is remarkably so transpiration takes place very readily. For this reason, trees like willows are planted in bogs to dry up the moisture in them.

Another specialisation of the cellulose is to be found in seaweeds. In them there is no epidermis, but the cells towards the periphery are crowded together, and the cell-walls, generally, become mucilaginous. When the tide recedes and leaves the algæ exposed, tbe mucilage hardens, giving them the horny appearance with which we are all familiar, when by any mischance they are withdrawn from their native element. The hardened mucilage prevents dessication of the protoplasm or living principle of the cells, and thus preserves the plant alive and intact. On being again covered with water, the mucilage readily absorbs the liquid, and immediately becomes softened and absorptive again, and the plant is restored to full vigour of life, having suffered no injury from its temporary embarrassment.

IV.—There are present in water, in addition to the carbon dioxide already spoken of, other salts that are essential to the well-being of the plant which are in a state of solution, and which enter the organism in the same manner. It might, then, be thought of advantage to a plant to fix itself in fast-running water, where a constant, ever-changing, and plentiful food supply would be presented to it. This is, however, far from being the case, and

there is great poverty of floral types in rapidly-flowing waters, compared with their abundance in still and quiet waters. Nor is the reason of this far to seek. All the particles in the water at the same place move at the same rapid rate, and it is impossible for a plant to select and absorb its food when placed under the resulting mechanical disadvantage, as sufficient time is not allowed for the act of absorption to take place. Moreover, even if this necessary act could be performed under the circumstances, it is a well-ascertained fact that water from natural sources contains a scarcity of those salts which can be assimilated by the plant as food.

On the Structure of the Root.

By Harold Wager, F.L.S.,

and

Norman Walker,

*Assistant in the Biological Laboratory, Yorkshire College.**

Plate IV.

THE roots of plants perform two functions. First, they fix the plant firmly in the soil and keep it upright; and second, they absorb food substances in the form of water containing mineral salts in solution. We shall appreciate the importance of the root when we remember that a plant is largely made up of water in one form or another, for all the solid material in the plant consists of water in combination with other substances, and a large amount of what may be called free water fills up the numerous spaces which occur in this solid structure. Now, very little, if any, water is absorbed by any part of the plant except the root. The water thus absorbed is ultimately carried upwards to all parts of the plant.

Furthermore, as the leaves absorb a certain kind of food—carbonic acid gas—from the air, which food is transformed by a series of chemical changes, first into sugar, then starch, and then again into sugar, in which form it is dissolved and distributed to other parts of the plant where such food is required, we must,

*Paper read to the Leeds Naturalists' Club on Nov. 1, 1895.

therefore, enquire into the structures by which this food material is carried downwards in the root.

We have, therefore, in the examination of a typical root, to see if we can determine by what special structures, if any, the following kinds of work are done:—

1.—Fixture and support of plant.

2.—Absorption of water.

3.—Conduction of water and food upwards.

4.—Conduction of food materials downwards.

We may obtain roots for examination in two ways. We may dig up roots growing in the soil, or we may plant seeds in sawdust and use the roots of the seedlings. The latter is the simpler and for many purposes the best method, as it is often difficult to clear roots obtained in the former way of all the particles of soil that adhere to them. As, however, the roots of seedlings have been well described in text-books, I propose to take a root that is not so well known, namely—that of the Common Lime, *Tilia Europea.*

The material is best obtained by digging up roots of a lime, and selecting those roots which have not had their apices broken off. Let us take one of the branches about the size of a knitting needle and examine its appearance. It is brownish in colour, and should possess a somewhat rounded tip. Some two or three inches behind the tip, lateral branches, rootlets, will be seen, light in colour and much smaller than the main root. About half an inch behind the apex of the root, there is a slight expansion of the root, covered by particles of soil which are rather difficult to rub off. This bulging portion extends for perhaps half-an-inch along the root. On washing it carefully in water, it will be found to be covered with delicate white hairs—the root-hairs—through which the absorption of water takes place. Notice how firmly the particles of soil stick to them, so that the hair is often torn on trying to rub the soil away. This is due to the fact that the surface of the hair often becomes transformed into a kind of jelly, in which particles of soil get embedded. These particles become decomposed and the mineral substances contained in them dissolved, partly owing to the secretion of an acid by the root-hairs, and the solution thus obtained is then absorbed.

Between the hairs and the root-tip, a clear space exists, deli-

cate looking and of a bright yellow colour. This is the growing point of the root, and it is here that the cells are in their simplest condition, and all new tissue has its origin. This root apex has to force its way between the particles of soil, and lest the delicate tissues of which it is composed should be injured, it is protected by a rough-looking, brown covering, called the root-cap, which is formed at the extreme apex. As the root-cap is worn away in its progress through the soil, it is renewed from the young growing-point. Behind the root-hairs the root is yellowish brown and somewhat rough-looking.

These are the only observations that can be made without the dissection of the root and the use of the microscope.

If we take transverse and longitudinal sections from various parts of the root, we can observe and locate the internal structures. For section-cutting, roots should be preserved and hardened in methylated spirit. They should be placed in 70 per cent. alcohol for at least twenty-four hours before cutting, or they may be preserved indefinitely in this solution. If pure methylated spirit cannot be obtained, absolute alcohol, although expensive, must be used. To test the purity of the methylated spirit add a little water to a small quantity. The spirit is unsuitable if the mixture turns milky. There are other methods of preserving and hardening, but methylated spirit is necessary with all of them, and the above is perhaps the best suited to a beginner.

In order to cut and mount sections, the following apparatus is necessary:—A sharp razor, three or four watch-glasses, two or three camel-hair brushes, a dish containing methylated spirit or absolute alcohol, a small bottle of a rather thin solution of Canada balsam in xylol, xylol or oil of cloves, a stock of 3 × 1 glass slips, thin cover-glasses, and a staining solution, such as Bismarck brown. The process of preparation may be divided into five operations:—

1.—*Sectionising.*—Take a piece of root, including the tip, about an inch in length. Hold this in a perfectly upright position between the forefinger and thumb of the left hand, the cut end slightly projecting above. Rest a sharp razor, well wetted with spirit, in a horizontal position on the tip of the forefinger, and draw it over the root so as to cut thin transverse slices. It is

important that the razor should be kept quite level and the piece of root in an upright position, otherwise there would be a danger of the sections being cut obliquely.

If any difficulty be found in holding the root firmly, it should be embedded in pith in the following manner:—Take a piece of elder pith, about one-third of an inch in diameter and as long as the material to be cut. Slice away the outer hard portions, and divide the remaining soft cylinder longitudinally in half. On the inner flat face of each half make a groove sufficiently deep and parallel to the sides, and fit the piece of root into these grooves; fasten the halves together with a ribbon pin and place the whole into 70 per cent. alcohol for a minute. The root is now supported on all sides by the pith, and sections are cut through pith and all. These are transferred to a watch-glass of 70 per cent. alcohol, and the pith sections picked out with a camel-hair brush. Draw off the alcohol by means of a pipette with an aperture too small to allow the sections to pass in, and add 30 per cent. alcohol. After the sections have come to rest, remove the weak alcohol and add water.

2.—*Staining.* Replace the water with a solution of iodine green and allow to stand for an hour, when the sections will be found to be much overstained. Draw off the iodine green and rapidly wash in 50 per cent. alcohol, which should be then drawn off quickly. Now treat the sections with a solution of Bismarck brown for ten minutes, and wash rapidly in 70 per cent. alcohol.

3.—*Dehydration.* The sections are now placed in methylated alcohol and then into absolute alcohol, to free them from all trace of water.

4.—*Clearing.* Replace the alcohol with a mixture of equal parts of absolute alcohol and oil of cloves. When the sections have come to rest, remove the mixture and add oil of cloves.

5.—*Mounting.*—The sections may now be picked out with a dry camel-hair brush and mounted in balsam. The section should be placed on the middle of the slide, a single drop of balsam placed on it, and covered by a thin, clean cover-glass. The preparation may be examined at once, but will not be dry for some days.

By this method the xylem, endodermis (and suberised tissue

in the older root) are stained green and the phloëm and cell-walls brown. The iodine green may be left out, in which case the sections should remain in the Bismarck brown solution for an hour, and then washed well in 70 per cent. alcohol. The phloëm and endodermis will be found to stain more deeply than the surrounding tissues.

Preparation of Solutions.

Alcohol :—

30%	Methylated spirit (unmineralised),	33 vols.	water-	66 vols.
50%	,, ,, ,,	56 ,,		44 ,,
70%	,, ,, ,,	78 ,,		22 ,,

Iodine Green Solution :—

Iodine green	0·5 gram.
Water	150 c.c.

Bismarck Brown Solution :—

Bismarck brown	1 gram.
70% alcohol	100 c.c.

A section taken just behind the root-hairs—say, one inch or a little more from the tip of the root—should be first examined, as it shows the typical structure.

With the naked eye or a pocket-lens, two distinct parts can be made out in the section : a central dark portion, which we call the central cylinder, and an outer lighter portion, the cortical cylinder (Fig. 1). Examined under a magnification of 50 to 100 diameters, we see that both the central and the cortical cylinders are made up of cylindrical or polygonal cells, varying in size and appearance, but all consisting of an outer wall or membrane and an internal cavity. Even with such a low power it is seen that the cells are differentiated into groups or bundles in the central cylinder, which is clearly marked off from the cortex by a ring of black cells, known as the endodermis (Fig. 2).

Let us now examine under a higher power (a 1/6th or 1/4th objective) a section double-stained with Bismarck brown and iodine green.

On the outside will be seen a more or less regular layer of cells, somewhat dark and rather smaller than the cells just inside it. This is the outer layer of the cortex (Fig. 2, *pt.*), and its function is to protect the delicate tissues inside it. For this purpose the

cell-walls have become to some extent cuticularised by the impregnation of part of the cell-wall with cutin, a substance something like cork and impervious to water. In the stem there is a distinct layer outside the cortex, set apart to perform this function; but in the root the layer which corresponds to the epidermis in the stem is used for another purpose, and the function of protection is taken on by the outer layer of cortical cells. If we look carefully enough, we shall see outside these cells a thin layer of a somewhat ragged brown substance (Fig. 2, *pl.*), which is all that remains of the outermost layer of the root corresponding to the epidermis of the stem. This outermost layer gives rise to the root-hairs, and is therefore called the piliferous layer, and its function is to absorb water and salts in solution.

Immediately inside the protective layer are several layers of cells somewhat circular in outline, and so arranged as to leave larger or smaller spaces between the cells (Fig. 2, *c*). These cells extend up to the limits of the central cylinder, and are called the cortical cells. They contain large quantities of water, and the interspaces may be regarded as air-spaces, through which air can reach the various tissues. The cortex sometimes acts as a storehouse for food, and in some roots is the seat of the formation of secondary structures, such as cork. The water contained in the cortex can be taken up when required by the plant, and through the cortical cells water is conducted from the root-hairs to the central cylinder.

The innermost layer of the cortex is called the endodermis (Fig. 2, *e*)—that is, inner skin—in contradistinction to the outer skin or epidermis. This layer has a peculiar structure. The cells are similar in shape and size and are closely fitted together like bricks, so that there are no air-spaces at all between them, and the communication between the air-spaces of the cortex and the central cylinder is completely cut off. Furthermore, these cells are cuticularised, but in the majority of cases the radial walls only are changed in this way, and not the tangential, inner and outer walls. Water can thus pass through the cells in a radial direction from the cortex to the central cylinder, but not sideways from one cell of the endodermis to another. In the lime, however, the endodermal cells appear to be cuticularised all round except in that

part of the root where the root-hairs are given off. We thus see that in the region of the root-hairs water can easily pass through the endodermis from the outside, but that in the higher regions of the root the complete cuticularisation of the endodermal cells prevents the passage of water inwards or outwards, so that the water taken into the central cylinder cannot escape.

Inside the endodermis we see that the cells of the central cylinder are grouped into masses or strands, and we shall find that each of these groups of cells has a certain function to perform. (A group of cells which performs any special function is called a tissue.) First, we shall notice six distinct bundles of cells, which possess very thick walls, and can be recognised quite easily, as they stain a greenish colour in the iodine green and Bismarck brown. These are termed the Xylem or wood, and in longitudinal section will be seen to consist of long fibres or tubes, marked by spiral or other thickenings or pits on the walls. It has been shown conclusively, by a series of elaborate experiments, that the function of these tubes is to conduct water from the roots to the other parts of the plant, and we can trace them to all parts of the plant, even to the tips of the leaves and to the smaller branches. These groups of tubes are called vascular bundles—*i.e.*, bundles of vessels.

Alternating with these bundles, and somewhat more circular or perhaps tangentially oval in outline, are other bundles of small, thin-walled cells (Fig. 2, *ph.*). These are not so clearly differentiated from the surrounding tissues as the xylem bundles. They have, however, a very definite structure and function. The structure can only be made out and the tissue clearly marked off from the surrounding cells by longitudinal sections, in which it will be seen that these bundles are made up principally of long tubes, interrupted at intervals by a transverse wall, which is perforated like a sieve. It is not easy for beginners to make out this structure in a root, as it requires extremely careful section-cutting, but such sieve-tubes or sieve-vessels can be easily obtained by cutting longitudinal sections of the stem of a cucurbitaceous plant. It has been shown that this tissue, to which the name of phloëm is given, is concerned in the passage of food material down the plant from the leaves through the stem to the roots. We have thus in the central cylinder two distinct sets of conducting tubes : one for

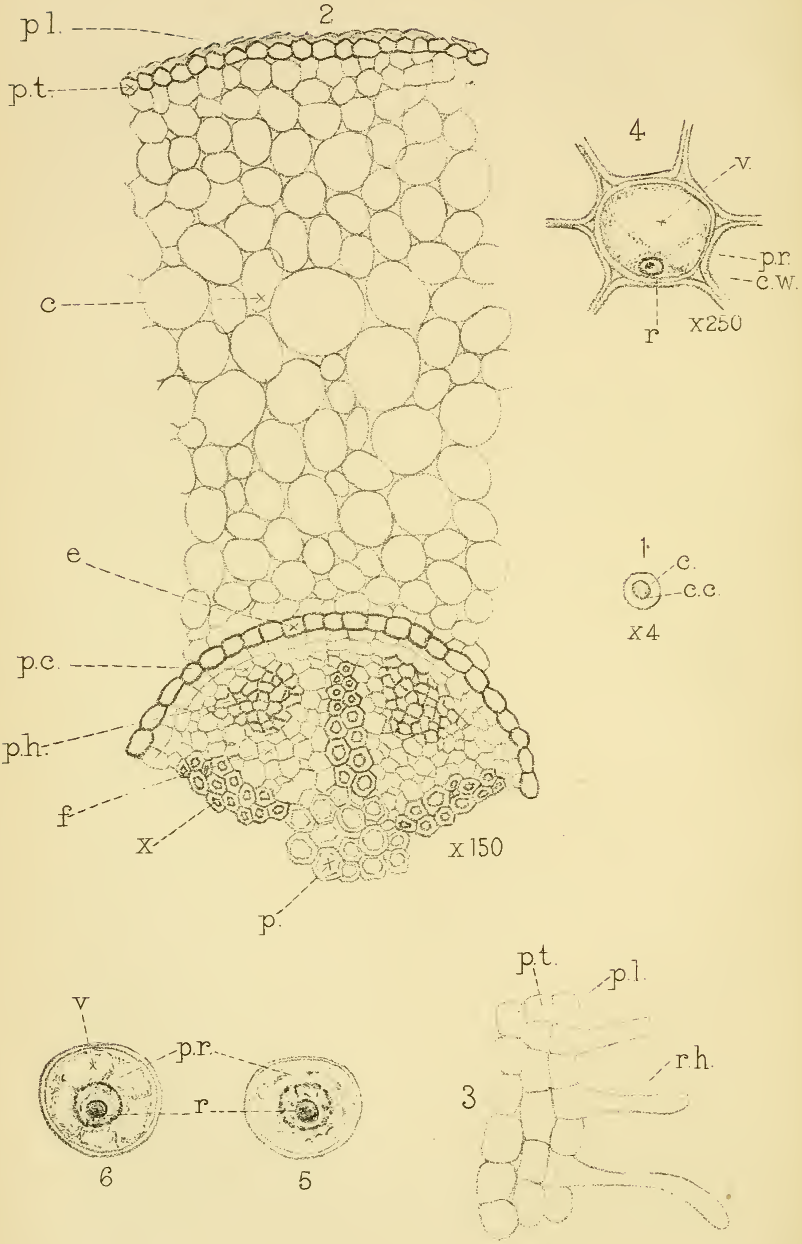
the upward conduction of water and salts in solution, and one for the passage of prepared food material downwards.

Between the endodermis and the vascular bundles are one or two layers of cells, known as the pericycle (Fig. 2, *pc.*). This layer is very important, inasmuch as it is the seat of origin of the lateral roots, which all begin to grow in this tissue, and force their way through the cells of the cortex by a process of digestion. The pericycle may also be the seat of changes which result in the formation of a new cortex, at the time when the old one is thrown off, owing to an increase in the size of the root.

The tissue around the vascular bundles is called parenchyma, or fundamental tissue, and is of the same nature as the cells of the cortex, both having undergone little change since their formation at the apex of the root. The centre of the root is occupied by the pith (Fig. 2, *p.*), which is also composed of parenchyma, but with somewhat thicker walls.

If we now examine sections cut in different regions of the root, we shall see that, according as the section is taken nearer or further from the apex, the structure will be less or more complex. In a section quite near the apex, all the cells have practically the same structure; we find there no differentiation into Xylem, Phloëm, Endodermis, etc. Each cell consists of a cell-wall, protoplasm, and nucleus. The protoplasm fills up the entire cell and contains no vacuoles (Fig. 5). A little further removed from the apex, we find that the cells have a slightly different structure. Vacuoles appear in the protoplasm, causing it to become restricted to the wall of the cell and to a few strands running out from that which surrounds the nucleus (Fig. 6). At the same time the cells are seen to differ in size, and groups of small cells, arranged regularly, represent the future vascular bundles. The further away from the apex, the more does the protoplasm become restricted to the wall of the cell; and in some cases it disappears entirely.

We can, in fact, show by a series of sections, longitudinal and transverse, that the formation of new cells takes place at the apex of the root, and that the various tissues of the root are produced by a gradual modification of these. To form the xylem the cells are gradually elongated, the transverse walls between groups of cells placed in rows end to end disappear, and long tubes or



Harold Wager, F.L.S., ad nat. del.

F. Phillips Sc.

Root Structure.

vessels are formed, strengthened by spiral, reticular, and irregular thickening of the wall; while at the same time the protoplasm disappears, so that these cells may now be said to be dead.

Modifications of a similar nature take place in the production of phloëm, but here the transverse walls are only partially broken down and converted into sieves, through which insoluble proteid matter, which is not capable of passing through organic membranes, is able to make its way. It must not be supposed that the sieve-plate functions as a sieve in the sense of sifting one thing from another. The reason for the existence of sieve-plates in what would be otherwise an open tube may be partly due to the necessity for some strengthening partition to prevent the collapse of such long, thin-walled tubes, and partly to enable the tubes to be completely closed at certain times—notably in winter, when very little active formation of food materials is taking place.

The parenchymatous cells of the cortex and the central cylinder are only slightly altered in structure from those described in Fig. 6. They possess a thin layer of protoplasm on their walls, a large central vacuole containing cell-sap, and a nucleus generally found in the layer of protoplasm on the cell-wall (Fig. 4).

Such is the general structure of the root, and the roots of all flowering plants will be found to possess this structure in principle at an early stage in their development. At a later stage, in the root of the Lime and others of a like nature, secondary formations appear, resulting in the production of a much larger quantity of xylem, until the greater part of the root becomes woody. This is the condition of all the older roots of our perennial dicotyledons.

EXPLANATION OF PLATE IV.

Fig. 1.—Transverse section of root, about 1 in. behind the apex, × 4: *c.*, Cortex; *c.c.*, Central cylinder.

,, 2.—The same section, magnified about 150 diameters:— *p.l.*, Remains of the piliferous layer; *pt.*, Outermost cortical layer, protective layer; *c.*, Cortex; *e.*, Endodermis; *p.c.*, pericycle; *f.*, Fundamental tissue—parenchyma; *ph.*, Phloëm or bast; *x.*, Xylem or wood; *p.*, Pith.

,, 3.—Section showing piliferous layer (somewhat diagrammatic):— *p.l.*, Piliferous layer; *r.h.*, Root-hairs; *pt*, Outermost layer of cortex.

Fig. 4.—A single cell of the cortex, magnified about 250 diameters :—
c.w., Cell-wall ; *pr.*, Protoplasm ; *v.*, Vacuole containing cell-sap ; *n.*, Nucleus with nucleolus.

,, 5.—A young cell from near the apex of the root, × 250 :—
pr., Protoplasm ; *v.*, Vacuole ; *n.*, Nucleus.

,, 6.—A young cell, further removed from the apex than Fig. 5. Same magnification ; lettering the same.

Selected Notes from the Postal Microscopical Society's Note-Books.

Ant-Lion (Larva of).—This insect is a very interesting one, and one about which considerable misapprehension exists ; at least, I was quite surprised when it was pointed out to me among the sand at the mouth of a large cave called the "Four de Berne," which is situated in the Cliffs that overhang the brawling stream which issues from the Val de Travers (Canton Neuchatel), Switzerland. On enquiring for the way to enter this gorge, to my surprise I found that the peasant to whom I spoke had suspected my nationality and spoke to me in good English, which he had acquired during a residence of several years in America.

He knew something of Geology, and took a most intelligent interest in other matters connected with Natural History, and not only showed me my way, but accompanied me for some distance, and took me to the entrance to this cave, where we parted.

He informed me that he had been employed by a Swiss gentleman some years ago to search for prehistoric remains, in which they had been very successful, and while we were sitting on a stone conversing together, he drew my attention to some long, narrow tracks which had been made in the dry sand, and asked if I knew what they were. I did not know, as I had never noticed such markings before. He pointed out that these winding tracks invariably ended in a little depression in the sand, circular in shape, with sloping sides, and about an inch deep. Putting his finger into the sand at the side of this hollow, he shoved it underneath, and from the bottom he haul'd out a dirty-looking little "critter," about the size or rather bigger than the one which is so thoroughly

squashed on Mr. Tait's slide. It seemed decidedly averse to being introduced to the daylight, and was woefully stubborn, for no amount of gentle titillation applied to the region where his tail would have been if he had one would induce him to move forward, but when the straw was applied to his head he wriggled himself backwards.

His appearance and demeanour suggested thoughts of the "amoosin' little cuss" of Artemus Ward. My guide (Emile was his name) informed me that they always travel backwards, and that when their little pit gets destroyed by being filled up with loose sand that they reconstruct it again by jerking out the sand by bending their abdominal segment under them, and then relaxing it again with some force. In this way they form their little pits in about a couple of hours, and then bury themselves in the sand below, only leaving the points of their mandibles exposed.

Any ant or small insect which unwarily passes over the brink of the little pit slides into it as the loose sand gives way beneath it, and it has nothing to which it can cling. "*Facilis descensus averni.*" It is easy to get in, but hard to get out. The horrid mandibles grip him, a struggle ensues; but it is soon over, and the plump body of the ant is soon reduced to the condition of a sucked orange. These little pits were very numerous at this place, but though I looked for them on several occasions elsewhere on my travels, I never saw any indications of their presence. They can only construct their pits where there is dry, loose sand or any light soil; a shower destroys the pits at once, and they can only be reconstructed when the sand becomes dry again.

J. C. Christie.

Aulacomnium Androgynum.—This moss is found growing rather plentifully on decaying stumps in damp woods. It is one of the Acrocarpus (terminal fruiting) section, but is very rarely found in fruit. To compensate for this, the male plant in spring sends up a short stalk bearing a number of gemmæ (which are analogous to the bulbels of some ferns and flowering plants, as *Asplenium bulbiliferum*, *Sileum tigrinum*, etc.). These gemmæ, when mature, fall to the ground, and grow up under favourable conditions into plants like the parent one. There is something very remarkable in the fact that this single cell grows directly into

a perfect plant, with roots, stem, leaves, and fruit. The change is far greater and more wonderful than in the lower forms of plant-life, where the cells increase by division, and the perfect plant is only unicellular.

The specific name, *Androgynum*, was given in error, it being formerly supposed that the gemmæ were the male flowers.

W. N. CHEESMAN.

Aulacomnium Androgynum.—This moss is described as having leaves "irregularly toothed at the apex" (Berkeley); "all denticulate at the apex" (Hobkirk), which I do not observe in Mr. Cheesman's specimen, except on two leaves, and that only obversely, even with ½-inch o.g. Is the "toothing" of the leaves always so very slight? Instead of each gemma being "a single cell," they appear to me to be as described by Berkeley in the *Handbook of Brit. Mosses*, p. 206:—"Broadly fusiform, apiculate, and 3—4 septate."

W. H. LETT.

Asterina.—Is a genus of Micro-fungi. One species, *A. Babingtonii*, grows on living box leaves:—"Perithecia semiorbicular, seated on a byssoid—*i.e.*, silky—mycelium, mouthless, at length splitting irregularly. Asci short, mostly sub-globose."

C. H. WADDELL.

Celsia, Stamens of.—The genus *Celsia* belongs to the *Solanaceæ*, and comes very near to the *Verbascum* (Mulleins), of which we have some wild examples in this country, all of which have hairy stamens. Several of the genus are natives of the Mediterranean district of S. Europe and N. Africa. The vase-like hairs at the base of the flower will not be overlooked. When the flower is quite fresh, the numerous trumpet-like hairs are very beautiful.

J. ROOKLEDGE.

Ammonites plavicostatus.—This is, if I remember rightly, a Lias species. The Ammonites, a genus of chambered shells, found only in the secondary rocks, but exceedingly abundant in some of them, are allied to the existing *Nautilus*, but differ from it by having the sutures between the several segments of the shell foliated like those of the human skull, whereas in the Nautilus they are straight. In the Nautilus, too, there is a single siphuncle or tube connecting the chambers which pierces the septa near the

centre, whereas in Ammonites there are several siphuncles at the margin of the septa. The shell of the Ammonites, when favourably preserved, shines like that of the Nautilus, with beautiful iridescent hues; it is of a nacreous structure, resembling that of the Gasteropods, or the inner layer of the shell of the Lamellibranch bivalves. H. F. PARSONS.

Alpine Rose, Leaf of the, from Montauvert.—The writer would feel obliged if some member would inform him the name of the Micro Fungi upon the same, and how to remove the beautiful star-shaped Raphides from the leaf, and the best method of mounting the same as transparent objects. The plant is believed to be a wild Rhododendron, and is very common in the Swiss mountains. Travellers are very fond of decking themselves with bunches of the crimson flowers to show that they have been for a climb. A. KEMPSON.

Ditto.—I have travelled through many miles of these, but had no idea that their apparently smooth leathery leaves were so beautifully covered with crystals. Though found at Montauvert, it is much more abundant a few miles further on the range; in making the ascent of Mont Blanc from Chamouni, the upper lower ranges are covered with it, reaching to Pierra Pontua, just below the Snow-line. J. ROOKLEDGE.

Ditto.—The two species of dwarf Rhododendron called "Alpine Rose" are *R. hirsutum* and *R. ferrigineum*; the latter is the one under observation. The beautiful discs on the *under side* of the leaves occur in both species, and are similar yet different. I formerly wrote some notes in our books on the subject, and enclosed specimens showing how these rosulate *hairs, not crystals*, extended over calyx and corolla, and therefore I now limit my remarks to saying that, by means of these hairs, I can often trace the parentage of garden hybrids known by mere florist's names, such as *R. Wilsoni*, *R. Getsoni*, etc. While writing, I find the species and varieties mentioned are now in full bloom in my garden. The hairs in *freshly gathered* blooms are lovely in the extreme—pressed and dried the vivid colours of the leaves and petals fade, and the appearance is as changed as that of a mummy from the living person.

Plant hairs should be studied on the living plants, and at various stages of growth; they are usually most dense on the unopened bud, their chief office being apparently to clothe and protect it, a happy illustration of utility and adornment combined.

It is desirable to cut sections of the leaves to show the attachment and embedding of the hairs. This is easy enough for the purposes of observation, although it is not so easy to mount permanent specimens, as a fluid mount is required. W. TEASDALE.

Ditto.—Some years since I made a careful examination of the hairs of a good many plants, and would strongly indicate the study of leaf appendages to the attention of any "low power" microscopist who is hard up for a subject to work at. Amongst Rhododendrons, the leaves of *R. Nuttalli* are, perhaps, the prettiest and most interesting. H. POCKLINGTON.

Acrostichum alcicorne is now known as *Platycerium alcicorne.* It is a native of the tropics, and is found in the East Indies, Malayan Archipelago, and Australia. The name *Acrostichum* was originally given to it and others whose fructification was borne on the end or tip of the fronds—ακρος (*acros*), highest; στιχος (*stichos*), order. The name Platycerium is given because the fronds are divided in broad segments like stags' horns, from the Greek πλατυς (*platys*) and κερας (*cepas*), a horn. W. H. LETT.

Aregma bulbosum (Bramble Brand).—This is the leaf fungus which produces the black dusty spot on the back of the Bramble leaves in autumn. It generally occurs in company with the *Puccinia* peculiar to the Bramble, which appears as bright yellow or orange spots; indeed, there seems every reason to believe that they are different forms of fruit of the same fungus. Both were very plentiful in this neighbourhood (Glasgow) this autumn (1882). I noticed a minute larva feeding on the spores of the *Puccinia*, which were quite visible in its interior. W. GOODWIN.

This *Aregma* is more common than is generally supposed. I found some fine specimens a day or two ago (Jan., 1883) growing upon a moss gathered near some bramble bushes. E. HUNTER.

Aregma obtusatum spores.—Mr. F. Carey investigated the structure of these spores, and one of his conclusions, quoted from the *Quarterly Journal of Microscopical Science*, is as follows:—

"The idea of the fruit consisting of Sporidia united together and forming a chain is certainly not in accordance with the true structure. The Sporidia are not united to one another in any way, but, although closely packed for want of space, they are, in fact, free in the interior of what may be called a sporangium or ascus." After explaining the manipulation employed to prepare the spores and fruits by which he arrived at this conclusion, he goes on to say:—"By this means the fruit"—*i.e.*, the whole spore as seen on slide—"was found to consist of an outer membrane nearly transparent (and studded with tubercles)"—this refers to any other species of *Aregma*—"and that this membrane enclosed a number of cells which constituted the apparent joints, and which were naturally flattened at either end by mutual pressure. When the outer membrane was dissolved or ruptured, these cells escaped and became detached from each other. The cells, thus set free, exhibited a brownish-yellow ring around a paler area, in the interior of which an inner cell was visible, sometimes globular, often irregular in shape. The examination of the ring was not entirely satisfactory; it appeared to be sometimes marked with concentric lines having the appearance of wrinkles. The inner cell had granular contents and a central nucleus. When perfectly free, they were spherical in form, with a distinct membrane of their own, but colourless, except when acted upon by reagents. The means employed to determine the existence of these cells was to soak the spores in muriatic acid; then upon pressure of the glass cover the outer membrane, and ringed cells were ruptured and the inner cell escaped." Although these remarks will be well known to those who have studied this branch of Microscopy, I have ventured to quote them in order to make the slide interesting to those who have not studied it. J. W. STEWARD.

Aregma obtusatum, Strawberry brand.—The specimen is, perhaps, one of a common species, but it embraces two kinds of spores, the relation between which is a matter of dispute with some of our best mycologists. The leaf is that of the wild strawberry, and the fungus upon it is one of the Aregma or genus having four to seven celled spores.

The present species is called by some *Phragmidium obtusatum*, but by Dr. W. C. Cooke, in his *Microscopic Fungi*, it is called

Aregma obtusatum. It is accompanied on the leaf by the orange spores of a species of *Lecythea.* Cooke says, in the work above referred to:—"The association of one-celled, orange-coloured spores with the brown two or more celled spores passed in review is another feature worthy of a passing notice, and which opens a field for discussion. It is generally admitted that these two forms are the production of the self-same mycelium or vegetative system, but it is not so generally admitted that they are but two forms or phases of the fruit of the same plant. It is not at all uncommon in the history of mycology to find two forms which were for a long time considered to be distinct plants producing different forms of fruit, and which bore different names, and were located in different genera, at length proved to be only the self-same plant in different conditions, and ending in one name being expunged from the list. Such a fate probably awaits, at no distant date, the orange spores which precede or accompany the species in the present genera (p. 74). T. Whitefoot, Jun.

Desmids.—One of the peculiarities of desmids is their exceeding symmetry, each half of the cell (for though apparently double, it is really single, as is shown if a puncture is made, the whole cell-contents being emptied) being identical, the same number of starch-grains, if they exist, being shared equally in the same relative places (the same with chlorophyll, etc.); this bilateral arrangement is, if I may use the term, very animal-like.

These organisms are best examined in their fresh state. On the slide the cell-walls show most distinctly; the interior contents, however, are not so clear. This, perhaps, is unavoidable in mounted specimens. J. Vereker.

Starch-Grains.—To recognise starch-grains, the best way is to place a drop of dilute aqueous solution of iodine in iodide of potassium in the water on the slide; the starch is coloured blue. Of course, the polariscope may be used instead, but the first process is very convenient, as it gives a blue colour, and the polariscope can be used as a confirming test. J. Vereker.

Palates of Mollusca for Polariscope.—These organs, sometimes called "tongues," are very curious. They are armed with sharp teeth, and differ as much in the molluscs as the antennæ in the

insects. Some authorities object to the popular term "tongue," and prefer the long word "odontophore."

It would appear from the testimony of several investigators of these beautiful objects, that they by no means invariably determine the species, "although the patterns or types of the lingual membranes are, on the whole, remarkably constant, yet their systematic value is not uniform, and therefore the attempts to remodel the Gasteropods by their peculiarities of dentition *have not become so complete a success as was at first expected.*"

Dr. Troschel, who has written a good deal on the subject, classifies the principal types by means of their lingual dentition, but the *generic* characters of each have yet to be ascertained. In the *Patella radiata* the teeth are very strong and numerous, being also nearly opaque; those of the *Trochus* are also very numerous, but the band is much wider, and "not only are the large teeth of the lateral bands very beautiful, but the delicate leaf-like teeth of the central portion have their edges minutely serrated."

The preparation of these palates is by no means easy. You have to "first catch your hare"—that is, you have to dissect the object from its surroundings, which are all of a slippery, slimy nature. Obviously, the dissection must be done under water. The first touch of the knife or forceps will in most cases have the happy effect of making the water so turbid that nothing can be seen. The water must then be changed, and the process will have to be repeated several times. Hogg gives the following method:—"The animal having been taken from its shell, pin down the muscular foot to a piece of cork, pour water upon it; then with a dissecting microscope and a good bull's-eye condenser cut open and expose to view the floor of the mouth; pin back the cut edges throughout its entire length, and work out the dental band with knife and forceps. When the band is detached, place it in a watch-glass, and again clean it well by repeated washings and a camel's hair brush; then place it in weak spirit and water, where it must remain for a few days before mounting. If the membrane is dense and fatty, it must be soaked for a time in liquor potassæ, and when removed carefully washed. The best fluids for mounting are weak spirit and water, glycerine, glycerine jelly, or Goadby's solution. Canada balsam renders them so very pellucid that the finer teeth are completely lost in it."

Dodder and its Host.—The Dodders (Cuscula) are parasitic on such plants as clover, nettle, hops, etc. Most of the species are annuals dying away in autumn. Before that time, however, the seeds have burst explosively from the seed vessels, and have been scattered hither and thither by the wind. All the winter they lie dormant in the ground, sheltered, in many cases, by decaying leaves, which supply a suitable soil for germination, which does not take place until comparatively late in the following year, not before the nettles and hops have acquired some strength of stem. From the seed proceeds a little club-shaped root, which seeks the soil, but the young stem remains surrounded by the seed-hooks and the store of nutriment which they contain. It grows thin as a thread, and somewhat spirally at the expense of the seed-stores, which, however, is soon exhausted ; the thin stem then seeks for some plant on which to cling. If this be not found, the stem at length lies prostrate on the ground, and after a strange dormant existence for a month or so dies ; but if some plant be near at hand, the dodder plant clings around it after the manner of a climbing plant. So soon as the stem has embraced that of its bearer—say, a nettle or hop plant—it throws out attaching papillæ, which penetrate the bark or cuticle, and sends out numerous little rootlets. These come into close connection with the bast portion of the hop or nettle stem, and from thence absorb nutrition. Now, the vessels of the bast form the channels by which the organic substances manufactured in the leaves pass towards the root. Such are the spoils which the leafless dodder, unable to manufacture organic material for itself, absorbs from its host. After suitable attachment has been effected, the stem continues its twining growth with increased vigour, and all connection with the soil is lost, and eventually the parasite bursts into flower.—From *Gedde's Chapters on Modern Botany.*

Leaf of Durio Zibethinus.—On the underside of the leaves are found two varieties of stellate hairs, there being first one or two layers with many rays, and under these a layer with only a few rays.

Leaf of Deutzia scabra.—These leaves are usually either mounted dry as an opaque object, or decolourised and stained, or the cuticle only may be mounted. The specimen now sent is

part of the leaf of the entire thickness, which, after a prolonged soaking in glycerine, was mounted in glycerine jelly without water. It should be viewed with polariscope without selenite, the prism being turned to give a dark ground; it may also be viewed with selenite.

Sozodont (a tooth powder).—This will be found to consist of diatoms and starch, the granules of the latter being exceedingly small.

Aspartic Acid.—When asparagin is dissolved in a saccharine liquid, which is afterwards made to ferment, or when heated in water under pressure in a closed vessel, or when boiled with either an acid or an alkali, it is converted into ammonia and aspartic acid.

Tingis crassicornis—syn. **Dictyonota crassicornis**—is one of the Hemiptera Heteroptera. These creatures are "in all stages of their existence active and suctorial, and the consequent difficulty of supplying them, in confinement, with fresh appropriate food, few observations upon their natural history have been made and recorded. There is a gradual development of the creature after it leaves the egg, not only in size, but in the perfection of its organs. The larva resembles the imago, and is said to cast its skin three times before it reaches the pupa state; the insect is then still more like the imago; but some of its organs—such as the ocelli, wings, and claws—are either rudimentary or are barely indicated, and only become perfected after the last moult. But whether each species casts its skin the same number of times, how long the individuals of each species remain as larva, pupa, or imago, what species have more than one brood in a year, and what constitutes the food of each species, are matters that in the great majority of instances remain to be determined."—*Douglass Scott* (1865).

Prepared Cocoa.—This preparation consists of cocoa, with a large addition of arrowroot and sugar. JOHN TERRY.

Prepared Cocoa.– I wish Mr. Terry had told us *which* "prepared cocoa" his specimen represents, for then we would give a wide berth to *that* kind, which has so little of the nutritive bean in it. This slide may give a hint to any of our members who have them, to circulate some slides of Adulterations.

A. CLARKE-SMITH.

Stylops Spencii (Parasite of Wild Bee).—The insects of this order, *Strepsiptera*, are of small size, the largest being not a quarter of an inch in length. The body is long and narrow, its greatest extent being occupied by a very large and singularly developed thorax. The general character of the body indicates great weakness, and we find accordingly that the insects live but a very short time in the imago state. The composition of the mouth is very singular, exhibiting none of that complicated structure we see in so many insects. This is in effect to be attributed to the fact that the imago take little, if any, food during its short existence. These insects are parasitic in their early state in the bodies of various bees and wasps, the larva, when fully grown, protruding its head between the abdominal segments of these insects, appearing at first sight like a small flattened acarus." From *Westwood's Classification of Insects*, where a long and interesting account of the order is given. JOHN TERRY.

Durio Zebethinus.—The stellate hairs of this plant are very beautiful objects. The tree is an evergreen and a native of the East Indies; it therefore requires a hothouse to grow in, and as it grows some sixty feet high, it is not likely to be very plentiful in this country. It belongs to the order *Malvaceæ*. J. W. CRICK.

Stylops Spencii.—Mr. Terry's remarks would appear to apply to the male insect only, seeing that the female is utterly degraded, and passes its entire existence within the body of the host, the head and part of the thorax only protruding between the abdominal rings, in some cases causing considerable distortion to the body.

I have never been so fortunate as to take a male specimen of Stylops, but some two or three years ago during a short stay at Swanage, in April, I found that in colonies of bees, of the genus *Halictus*, fully 25 per cent. of the swarm were stylopsed. The sac-like abdomen was crowded with multitudes of minute Stylops larvæ, which at that time—possessing six legs and two long hair-like appendages to the abdomen—presented a very different appearance to either the mature male or female. E. BOSTOCK.

Dodder.—At Crowboro' I found a quantity of dodder on the common Heath. A. CLARKE-SMITH.

Sozodont Tooth Powder comes from Virginia City, Nevada, California. A specimen in my possession has many more diatoms in it than this one. It is the silex of the diatoms that gives the imputed value to this dentifrice. A. CLARKE-SMITH.

Stylops.—A very good description of this insect, with figures, may be found in *Science Gossip*, 1870, p. 4. Shuckard also gives them a paragraph in *British Bees*, p. 208. CHAS. D. SOAR.

Atypus sulzeri.—This spider is glossy, the cephalothorax of the female is reddish brown. The male is darker; a smooth oval space, of a leathery substance, occurs on the front half of the upper side of the abdomen in the male. This spider is easily known by the great size of the cephalothorax and falces.

Atypus forms a tunnel in damp earth; at the end of this gallery, which runs in a horizontal direction at first, and dips down afterwards, the spider remains crouching and waiting for its prey. The female deposits there her cocoon, which is guarded from the dampness of the earth by being placed on a cushion, formed of a sticky material and the fibres of plants. Atypus feigns death when taken. CHAS. D. SOAR.

Clutiona amarantha.—In this spider the front row of eyes is the shorter, the middle eyes of the head row are rather wide apart; the falces are hairy and have a few small teeth; the maxillæ are strong, straight, and gibbous, enlarged at the insertions of the palpi. The lip is small at the base, and cut straight at the tip; the breast-plate is oval; the cephalothorax is broadest behind, and wide at the face; the shield is yellowish-brown, reddish in front, and thinly clothed with hairs, a few black hairs also occurring on the fore part. A dark line reaches about half of its length, and is succeeded by a series of lines in the form of obtuse angles, diminishing in length as they approach the tips. The legs are hairy, spinous, and pale, and there is a hair pad below the claws. The female is a little more than a quarter of an inch long. They feed much upon the eggs of other spiders.

The above has been slightly abbreviated from Staveley's *British Spiders*. Spiders would prove a most interesting study. I should like to see it taken up more than has been done by our members lately. CHAS. D. SOAR.

Microscopical Technique.

Preparing the Ovaries of Scilla patula.—Miss Lily H. Huie finds that the best method for preparing the ovaries of *S. patula*, in order to demonstrate the protein crystalloids, is by first fixing in Mann's Watery Corrosive Fluid. "To a boiling 0·75 per cent, common salt solution, sublimate is added to saturation (12 grm. for 100 cc.). The solution is then allowed to cool, when crystals of sublimate make their appearance. Preserve the solution without decanting.—*M. Heidenhain.*

Martin Heidenhain's corrosive sublimate solution	...	...	...	100 cc.
Picric Acid	...	...	...	1 grm.
Tannic Acid	...	...	...	1 grm.

"The tissues were carefully dehydrated and taken through chloroform into paraffin, and serial sections cut not thicker than 2–3 μ. . . The paraffin sections were spread out on warm water (40—45° C.), after Gulland, and fixed to the slide by Mann's albumen method, and then stained in Mann's methylblau-eosine mixture as follows:—

Requisites.—The staining fluid:—

a.—1 per cent. methylblau in distilled water			...	35 cc.
1 per cent. water-soluble eosin in distilled water ...	...	...	...	45 cc.
Distilled water	...	...	..	100 cc.

b.—1 per cent. caustic soda solution in alc. absol.

The Methylwasserblau (C37H26N3S3O9 Na 3) was obtained from Dr. Grübler, Leipzig.

Method.

1.—Stain for twenty-four hours.

2.—Rinse the dark-blue sections in ordinary water.

3.—Dehydrate thoroughly with absolute alcohol.

4.—Transfer the slide to a vessel containing: Absolute alcohol, 30 cc., and 1 per cent. caustic soda solution in absolute alcohol, 4 drops. Wait till sections are of a rust colour.

5.—Remove all traces of caustic soda with absolute alcohol.

6.—Rinse sections in ordinary water for one minute. Red clouds are given off and the sections become bluish.

7.—Place slides for two minutes into water slightly acidified with acetic acid. This is done to deepen and fully restore the blue colour, and also to fix the eosin.

8.—Dehydrate, clear with xylol (not clove oil), and mount in turpentine balsam."

Preparing and Mounting Head and Proboscis of Blow-Fly.*— Mr. T. J. Body thus describes his method:—"First catch the flies; kill them with chloroform and their tongues will protrude; cut the heads off and drop them into a vial of strong carbolic acid; let them remain there a few days or until a convenient time; take a head out of the vial, and place it on a glass slide or slip; puncture the head with a needle, and put over it another slide and press it flat; separate the slips and clean them off (do this several times); place the object on the stage of the dissecting microscope and examine it carefully; remove all loose, extraneous matter from around the head; if the tongue is crooked or the antennæ are folded over, place them in the position in which they are to remain; then press again between two slips and put on a clip, and let it remain so until the next evening (I do all my work in the evenings); soak again for a day or two in carbolised turpentine; wash well in water to remove the acid, using a camel's-hair brush for this purpose; then dry between two slips, say, for a day or so; then soak in clove oil until ready to mount. Prepare a cell of gold-size to suit a 5/8 or 3/4 cover glass some two weeks or more in advance of the time for using it. Remove the object from the clove oil, and remove all the oil possible with blotting-paper without touching the object. Put a small drop of benzol balsam on the centre of the slide, and with a wooden toothpick or needle spread it so as to cover the space within the cell; place the head in the centre of the cell and drop a small drop of benzol balsam on it; this will just fill the cell nicely, but it will be a little high in the centre. Place a clean, warm cover as nearly central as possible, and let it fall of its own weight; if the balsam is a little thick, some gentle pressure may be used, and when the cover is

* *The Observer* (*Practical Microscopy*), vi., 1895, pp. 56—57.

down see that it is central, and put on a spring clip; a little balsam will ooze out in five or six drops around the cover; lay it aside to harden. In about a week's time take off the clip, put the slip on the turn-table, and if the cover has moved, or is not central, push on the excentric side, then put on the clip, and in a week's time, provided care is used in handling, the overflow of balsam can be removed and the mount cleaned around the cell (I do all this work on the turn-table), and a seal of shellac varnish put around it. This dries quickly, and the following evening it can be ringed with King's Scarlet, Brunswick Black, or some other cement. When the second coat has dried hard, ring again. A finishing coat may be put on, but I find it best to wash the mount well in soap and water, using a tooth-brush as a scrubber, before putting on the last finishing touches. . . . Before putting the balsam in the cell, cut four notches, equidistant apart, through the cell, large enough for a fine needle to pass through, then proceed as above. These notches are for the purpose of moving or adjusting the object in the cell; also to allow for the shrinkage of the mountant. If the object is not central, a fine needle or wire, or a stiff bristle, can be pushed through one of the notches and the object moved to suit the eye.

Neutral Red.*—According to Prof. Ehrlich this new pigment is excellently adapted for biological researches and vital staining, as it possesses a striking affinity for living tissues. If tadpoles be placed in solutions of 1/10,000 up to 1/100,000, the animals become stained in quite a short time, and during the first and second day of their immersion absorb so much of the pigment that all their tissues become dark red. The pigment may be seen in the cells as minute granules. Larger animals may be subcutaneously injected, and even feeding with the pigment gives good results. In germinating plants the author obtained successful staining results, and by combination with other pigments—*e.g.*, methylen blue, etc.—a double or triple staining.

Ehrlich's Triple Stain.†—Dr. G. Reinbach gives a formula for the triple stain, as improved by Ehrlich. The author used it for

* *Allgem. Med. Centralzeit.*, 1894, *vide Journ. R.M.S.*, 1895, p. 128.

† *Arch. f. Klin. Chirurg.*, XLVI., *vide Journ. R.M.S.*, 1895, p. 129.

staining cover-glass preparations of blood. Its composition is as follows :—Saturated aqueous solutions of orange, G., 120 grm.; acid rubin, 80 grm.; methyl green, 100 grm.; H_2O (water), 300 grm.; absolute alcohol, 180 grm.; glycerin, 50 grm. The aqueous solutions must be saturated. The mixture is not to be shaken, but the necessary quantity should be pipetted off. The fixed cover-glass film is treated with the solution for five to ten minutes; the superfluous stain is washed off with distilled water, the surface dried with blotting paper, and the preparation mounted in balsam.

New Staining Process.*—Dr. O. Zacharias recommends the following process for both animal and vegetable preparations. The material is laid in 70 per cent. alcohol, and then, for from sixteen to fifty-four hours, in acetic carmine, prepared by boiling 1 gr. powdered carmine for twenty minutes in 150—200 gr. dilute acetic acid, and filtering when it has become cold. The preparation is washed in dilute acetic acid, and then placed for from two to three hours in ferric-oxide-ammonium-citrate.

New Fixing Material.†—Under the name "chrome-potash-sublimate-glacial-acetic-acid," Herr Zenker recommends a fixing material for vegetable tissues, which has the advantage of penetrating the tissue readily, without producing any shrinking. Its composition is as follows :—100 parts distilled water, 5 sublimate, 2·5 double potassium chromate, 1 sodium sulphate, 5 glacial acetic acid. It may also be used for preparations of the nervous system.

Cytotropism of Cleavage Cells.‡—The following is Professor Wilhelm Roux's method for demonstrating the phenomena of cytotropism :—The eggs of Rana fusca, obtained from newly captured animals at the beginning of the normal period of spawning, furnished the best material for observation. . . . The phenomena of cytotropism are seen most readily between cells separated from the egg in the morula or blastula stage. The separation is effected by cutting or tearing the egg in an indifferent

* *Forschungober Biol. Stat. Plon.*, *vide Journ. R.M.S.*, 1895, p. 127.

† *Münch. Med. Wochenschr.*, XXVII., *vide Journ. R.M.S.*, 1895, p. 130.

‡ *American Naturalist*, XXIX., 1895, pp. 511—12, from *Arch. f. Entw'mech. d. Organismen*, II., pp. 44—48.

fluid, such as the white of a hen's egg, or a $\frac{1}{2}$ per cent. salt solution. One requires for such experiments a small quantity (5—10 ccm.) of freshly prepared white of egg each day. This is prepared by filtering, in an uncut state, through a wad of cotton. The preparation must be perfectly clear. The egg, in the morula or blastula stage, is first stripped of its gelatinous envelope, and placed on a circular glass plate, about 3 cm. in diameter; then covered with about 5 drops of the prepared white of egg, and torn open with two dissecting needles; or, after puncturing with one needle, cut with a small curved pair of scissors. The outflowing parts of the egg are then cautiously reduced in size by a few movements of the needles. The circular plate is then placed in a round glass dish (4—5 cm. in diameter), with a rim 1 cm. high, containing 10—15 drops of water—just enough to fill the space between the edge of the object-plate and the rim of the dish, but not enough to come in contact with the white. The purpose of the dish and the water is to check the evaporation of the medium in which the egg lies, and thus to guard as far as possible against concentration of the medium and currents in the same. The dish offers the advantage that one, on interrupting the observation, can cover it and so protect the preparation against evaporation. Thus protected, cells may be kept alive in a suitable medium for one or two days. The preparation should be immediately examined, while in the dish, with a low objective (*e.g.*, Zeiss, A). It is important that the table of the microscope and the object-plate bearing the preparation should be perfectly level. The examination of isolated cells in an uncovered medium has the advantage that one can easily change the position of the cells with needles or other means. But it is indispensable for checking results to examine also preparations covered with a cover-slip. The cover-slip for this purpose must be large enough, so that at least two of the wax feet ($\frac{3}{4}$ mm. high) supporting it may fall on dry points of the object-plate, where they will firmly adhere and not allow the cover to slide. A still more complete protection against currents in the medium may be had by having a moist chamber ground into the object-plate, and covered with a large cover-slip. The bottom of the chamber must be flat and horizontal.

After separating the cells of an egg, one searches at first with

a low power (Zeiss, A) to find two cells separated from each other by a distance equal to, or less than, the radius of the smaller cell, and from all other cells by a distance not less than about double the diameter of the cells. No yolk substance should lie between or beneath the cells. Such a pair of cells having been found, higher objectives (Zeiss, C or D) may be turned upon them, and the cell so adjusted under the ocular micrometer, that the line connecting their centres will fall length-wise of the micrometer. In this position, one can easily see whether the cells move towards, or away from, each other.

Microscopical Analysis of Steel.—At a recent conference held under the auspices of the French Society for the Encouragement of National Industry, M. Osmond described a method for the microscopical analysis of steel. The method proposed comprises, in addition to the preliminary process of preparing the polished surface, three operations: (1) Polishing in bas-relief on parchment with a very small quantity of English rouge mixed with water; (2) Etching and polishing on parchment with a mixture of calcium sulphate, in precipitate, in a suitable vehicle; and (3) Etching with tincture of iodine and nitric acid. These three operations enable one to recognise in the steel five constituents. These five constituents are associated in combination to form the complex edifice of the structure of steel.

M. Osmond examined four types of steel, possessing a known proportion of carbon, to discover the manner in which these combinations varied. As a result of that investigation, M. Osmond states that the thermic treatment of steel leaves in the structure of the metal, when cooled, characteristic indications sufficiently precise to form a useful guide in the manufacture of steel, and also to enable consumers to determine the quality of the metal supplied to them.—*Scientific American.*

Incinerated Leaf of Deutzia.—At the annual exhibition of the Department of Microscopy of the Brooklyn Institute, U.S.A., held in January, Mr. G. M. Hopkins, of the *Scientific American*, exhibited a beautiful preparation of Deutzia leaf, which seems to have the merit of novelty. The leaf was reduced to white ashes, leaving the star-like hairs *in situ.* Some of the hairs were black-

ened by the carbon of the leaf; others were white, with pearl-coloured nodules ranged along the rays of the stars, like so many real pearls.

Mr. Hopkins' method of preparing this object is as follows:—A small piece of the dried leaf is placed upon a thin, flat copper plate, and another flat copper plate is laid upon it to keep it straight. Strong pressure is not required. The plates are now heated slowly over a flame until they become red hot; they are then allowed to cool, and the upper plate is removed. The piece of leaf is then found to be carbonised and considerably shrunken. Without replacing the upper copper plate, the lower plate with the carbonised leaf is again brought to a red heat, and, lastly, the flame is brought into actual contact with the leaf, thus removing the last trace of carbon, having nothing but the stars and the white ash.

The object is very tender, but it may be handled with proper care and may be mounted dry. If it is desired to secure the stars separate from the ash, one or two incinerated leaves may be placed in a small metallic box and shaken up until the leaf is disintegrated, when the stars may be picked out.—*The Microscopical Bulletin.*

Tissues Hardened in Formalin.—Dr. Mayer says*:—"The preparation put on the market is used in a 3—5 per cent. solution, as a fixative and hardening agent. The stronger solutions (10 per cent. and more) harden better and more rapidly, but for a preserving fluid the lower concentrations are preferable. The advantage of formalin is best shown in transparent tissues (cornea, cysts); and wherever colours are to be preserved that would be destroyed by Müller's fluid or extracted by alcohol. The results with the nervous system are very satisfactory, the relations of grey and white matter remaining very distinct. One noteworthy feature is that the vapours alone are excellent preservers, so that, if the specimen should happen to be incompletely immersed, it would nevertheless keep very satisfactorily if it is kept from drying out. Such an accident would prove fatal with most other methods. For histological purposes the fixation is best obtained with more concentrated solutions.

**Journal of Insanity*, July, 1895, p. 131.

Examination of Sputum for Tubercle Bacillus.—Spengler (*Deutsch. Med. Woch.*, 1895, No. 15) describes a new method for the preparation of sputum, which it is desired to investigate for the presence of tubercle bacilli. Equal volumes of sputum and of warm water rendered feebly alkaline with caustic soda are well mixed with 0·1 to 1·0 per cent. of trypsin and placed in the incubator. Putrefaction is prevented by the addition, two or three hours later, of a small quantity of crystalline carbolic acid. As soon as a deposit has formed, the supernatant fluid is poured off, the deposit was had with pure alkaline water and again placed in the incubator. This process is repeated several times, and finally the sediment is collected upon a filter paper and dried somewhat. Portions are then stained in the usual way. As a rule, in twelve to twenty-four hours, so little sediment remains that only a few microscopic slides are needed. If the digestion of the sputum be not carried on for too long a time, the tubercle bacilli undergo no modification in their staining properties.—*Brit. Med. Journal.*

Rapid Staining.—Cullen (*Centr. f. allge. Path. u. Patholog. Anat.*, 1895, Bd. VI., No. II., p. 448) describes a rapid method for staining fresh tissues after hardening with formalin. Sections can be stained in the *post-mortem* room within fifteen minutes of removal of the tissue from the body. The fresh material is frozen, and sections are cut and placed in 50 per cent. watery solution of formalin for five minutes, thence into 50 per cent. alcohol (one minute), and washed in water; they may then be stained and mounted in the usual way. Another method by which better results are obtained takes two hours and a quarter. In it the fresh material is soaked in a 10 per cent. watery solution of formalin for two hours, and then frozen, cut, and placed in 50 per cent. alcohol, The later procedure is as in the previous method. The pieces of tissue in the second method must not be greater than two millimetres in thickness.—*Brit. Med. Journal.*

Staining the Wings of Insects.—In No. 4 of Vol. I. of the *Biological Review of Ontario*, Dr. H. W. Hill gives the following method, devised at the request of Dr. Brodie, of staining the veins in the wings of certain insects :—

Place the whole insect in a strong alcoholic solution of fuchsin and allow it to remain there for forty-eight hours. Then

transfer the insect to water with a pair of fine forceps, and wash it till no more colour comes away, changing the water if necessary. While the washed insect floats in clear water, slip a microscope slide under it, raise the slide, holding the insect on it with a fine needle; separate the wings from the body with a fine scalpel and remove the body. With a drop or two of clear water on the slide, float the wings into any desired position, keeping them flat and unwrinkled, taking care to have no bubbles under them. Remove any excess of water with blotting paper, and allow the wings to dry. Then place a drop of thick Canada balsam near them and heat the slide over a spirit or gas flame. Tilt the slide so that the now liquefied balsam flows over the wings; lower a cover-glass gently into position, and allow the preparation to cool. In examination the veins will be found red, the depth of the colouring varying with the length of time of staining, the thickness of the veins, etc. The colour is well retained, so far as has been tried, and successful photographs have been made.—*Scientific American.*

Improved Borax Carmine Staining Solution.—The ordinary aqueous solution of borax carmine, widely employed in vegetable histology, requires almost always the destruction of the cell contents, so that only skeleton-like preparations have been hitherto produced with this stain. Professor Radais obviates this objection, however, by the use of an alcoholic tincture, thus prepared: Powdered carmine, 2 parts; borax, 8 parts; alcohol, 70 per cent., by volume 200 parts. This mixture is placed in a flask fitted to an upright condenser and heated on the water, so that the alcohol boils for twenty minutes. The liquid is then cooled and filtered. It is essential that the alcohol should be fully 70 per cent. by volume, so that if an efficient condenser is not available the strength should be 71 to 72 per cent. at starting. This carmine solution keeps well in stoppered bottles. Sections should first be macerated for a few minutes in a little 70 per cent. alcohol before being introduced into the stain; in favourable cases ten minutes at least are necessary to obtain a well-stained result, but the section may be left in the dye indefinitely without any fear of overstaining. After withdrawing from the stain, the sections should first be washed with 70 per cent. alcohol, and then dehydrated with alco-

hol of greater strength, and finally mounted in an anhydrous medium. This alcoholic borax-carmine tincture answers equally well for double-staining, using iodine green or methylene violet for the complementary stain.—*Journ. de Pharm.* in *Pharm. Journ.*

Reagent for the Detection of Mucilage in Plant-Cells.—Guiraud* employs a saturated solution of almost colourless hæmatoxylin in absolute alcohol, mixed with 100 times its volume in hot saturated solution of ammonia alum, as a reagent for the detection of mucilage in plant cells. The rose-coloured liquid deposits alum and becomes violet; it is then filtered and mixed with 30 per cent. of glycerine by measure. This reagent has the advantage of staining only the contents of the mucilage cells, and not their walls.—*Pharmaceutical Journal.*

Preparation of Clear Nutritive Agar.—In preparing a nutritive medium for agar-agar, difficulty is often experienced in obtaining a clear product, filtration being very tedious. A simple apparatus, devised by Dr. M. Bleish (*Centralb. für Bakt. und Parazit.*, xvii., 403) obviates the necessity of filtration, and yet enables a clear preparation to be obtained. A cylindrical glass vessel, of about two litres capacity, has openings at top and bottom. A perforated rubber cork closes the lower opening, and through it slides a glass tube, long enough to reach the top of the cylinder. Fix the latter in a retort-stand clamp and pour in the prepared agar until it nearly reaches the top of the sliding-tube; then place the whole apparatus in an oven at 50°—60° C., until all the solid particles have been deposited. The apparatus is now removed, a rubber tube with a clamp is fixed to the lower extremity of the glass tube, and the latter then drawn down a few centimetres below the surface of the agar. On opening the clamp the clear agar runs through and is collected in a suitable vessel, and the glass tube is gradually lowered from time to time until the whole of the clear fluid is removed. It is stated that precipitation of the solid particles may be facilitated by substituting sodium phosphate for the carbonate generally used.—*Pharm. Journal.*

Varnish for Finishing Slides.—In selecting a varnish for finishing slides on which microscopic objects are mounted, it is well to

* *Répert de Pharm.*, 1895, p. 71.

bear in mind that the cedar-oil, used with immersion objectives, is a powerful solvent, and may irretrievably damage valuable slides finished with a varnish, containing ingredients soluble in the oil. Since it is generally found advisable, for the sake of uniformity, to use one and the same varnish always, this should be selected with due regard to the possible use of cedar-oil as an immersion fluid. One of the simplest varnishes to make and use—sealing-wax varnish—is also unaffected by cedar-oil. It should be made by dissolving the finest sealing wax (preferably black) in methylated spirit, and of such a consistency as to flow easily from the brush. Before applying the varnish, the glass cover should be firmly cemented with caoutchouc cement (Beale's formula, dissolve separately equal parts of bottle india-rubber and shellac in mineral naphtha to desired consistence), or the Gram-Rützou composition (Canada balsam, 5 gm ; shellac, 5 gm. ; absolute alcohol, 5 gm. ; ether, 10 gm.). When the cement is quite dry, and not before, apply a thin coat of the varnish. A somewhat important point is the kind of brush to use. Best of all are sable "writing pencils," "crow," and "small duck" being suitable-sized quills. These do not come to a point when in use, and form perfect rings with less trouble than those that do. They should be carefully washed after use in alcohol, mineral naphtha, or turpentine, according to the nature of the cement or varnish employed.—*Pharm. Journal.*

Micro-Photographic Drawings.—Unna, the eminent dermatologist of Hamburg, suggested in 1892 a method of making reproductions of micro-organisms, which is much superior to the ordinary methods of either drawing or photography, combining the accuracy of the latter with the clearness and comprehensiveness of the former. The method is as follows :—

From properly stained specimens negatives are made. From these negatives light prints are made on soft paper, upon which it is possible either to draw or paint without further preparation. The photographs thus obtained give only the outlines of the object or a skeleton of the picture which it is intended to produce. By the aid of the micrometer screw of the microscope, the appearance presented in the various strata of the specimen may be easily sketched in by an artist. A more complete picture may

be reproduced by the half-tone process, and thus better results obtained than are possible by either drawing or photography alone —*Modern Medicine.*

Notes.

DR. Cole, in his microscopical reminiscences, speaks most highly of Spencer and Son's objectives. He says:—"I know that with a Spencer one-tenth homogeneous immersion, N.A. 1·38, belonging to my friend, Mr. Henry Benett, I have resolved the dots in *Amphipleura pellucida* as clearly and distinctly as those shown by Dr. Henry Van Heurck in *The Microscope* as the result of photographing the frustule with Zeiss's two-millimetre objective, N.A. 1·63. The result was achieved under the following conditions, which, by measurement, increased the N.A. of the objective from 1·38 to 1·52. The objective was made with wide collar correction for use with a 10-inch tube, the English and American standard. By Dr. Henry G. Piffard's suggestion, the tube was shortened to the Continental standard—six inches—the systems closed, monobromide of naphthaline used as immersion fluid for both objective and condenser, and a slide of *Amphipleura pellucida*, which I had mounted especially in media of nearly 2·5 refractive index, placed in position on the stage. The result was simply wonderful. The beads stood out as distinctly as those of *Pleurosigma angulatum* under a good immersion objective. The same slide, under similar conditions, was afterwards shown by Dr. Piffard to Spencer himself and Dr. Curtis, President of the American Microscopical Society. Both were delighted, and said they had never before seen such perfect resolution of the diatom. I think Spencer's lenses, for all practical purposes, equal to Zeiss's, while, having no fluorspar in their composition, they are not subject to disease. No special slides, cover-glass, condenser, or eyepieces are required."

At the March meeting of the Royal Microscopical Society, Mr. Conrad Beck told a funny story about a gentleman who had invented a microscope which was said to possess the remarkable power of showing chemical molecules. Mr. Beck went to see the instrument, "and found that the microscope had not at present done this, but it was about to do so. It was a home-made instrument, and had been devised by a gentleman who had made the

discovery that by drawing out the draw-tube an increase of magnifying power could be obtained, and who was of opinion that with an unlimited length of tube an unlimited power could be got; and that by using an electric light and a ½-inch objective, he would, by going to the top of the house and looking down through an eyepiece, be able to obtain enormous magnifying power!"—*Journ. R.M.S.*, 1895, p. 256.

In a recent number of *The Diatomiste* (II., pp. 39, 40), Prof. J. Brun claims to have settled the question that the pearls of diatoms are cavities, and not protuberances, in the following way: If a particle of a transparent body immersed in a liquid is first exactly focussed under the microscope and the tube then raised, the object will appear to have a bright centre if its index of refraction is higher than that of the liquid; a dark centre if the index is lower. If the tube is lowered, the results are the opposite.

If a diatom with large areas—such as a *Coscinodiscus*—is immersed in styrax or monobromide of naphthalin, and examined in this way, the pentagonal siliceous network is shown to have a lower index of refraction than the styrax, while the interior of the pentagon has not, showing that it must be a cavity, with the same index as that of the surrounding medium. If immersed in water, the inverse phenomenon is observed.—*Journ. R.M.S.*, 1895, p. 213.

Mr. G. C. Whipple thus sums up an interesting paper, which he has contributed to the *Technology Quarterly* (VII., 1894, pp. 214—231), anent the growth of diatoms in surface waters: he considers "That the growth of diatoms in ponds is directly connected with the phenomenon of stagnation; that their development does not occur when the lower strata of water are quiescent, on account of greater density, but rather during those periods of the year when the water is in circulation from top to bottom.

That diatoms flourish best in ponds having muddy bottoms.

That in deep ponds there are two well defined periods of growth: one in the spring and one in the fall; that in shallow ponds there is usually a spring growth, but no regular fall growth, and that other growths may occur at irregular intervals, as the wind happens to stir up the water.

That the two most important conditions for the growth of diatoms are a sufficient supply of nitrates and a free circulation of air, and that both these conditions are found at those periods of the year when the water is in circulation.

That while temperature has possibly a slight influence on the growth of diatoms, it is of so little importance that it does not affect their seasonal distribution.

That the increase of diatoms takes place substantially in

accordance with the law of geometrical progression, and that the cessation of their growth is caused by the diminution of their food supply."

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At the January meeting of the Geological Society (*Quarterly Journ. Geol. Soc.*, LI., pp. 196—209), Mr. E. B. Wethered read an interesting paper on the formation of oolite. We have already noted Dr. Rothpletz' work on the oolitic granules from the Red Sea and Great Salt Lake. Mr. Wethered's views are that "minute fragments of remains of calcareous organisms—such as corals, polyzoa, foraminifera, crinoids, etc.—collected on the floor of the sea. These became nuclei, to which the oolitic-forming organisms attached themselves, gradually building up a crust. Sometimes this growth was concentric; sometimes at right angles to the nucleus of the two combined. When the growth was concentric, other tubules frequently cropped up in other directions and crossed the concentric tubules. At the same time calcareous material was secreted, and the interstitial spaces between the tubules were filled."

In the discussion arising from Mr. Wethered's paper, Dr. G. J. Hinde pointed out the striking similarity in the microscopic structure of the oolitic grains from Great Salt Lake to that of the Palæozoic and later oolites, and thought that "if the algal origin of the former should be confirmed, there could hardly remain any doubt that the latter was similarly derived." Prof. Judd said that in 1862 Dr. F. Cohn "pointed out the important part played by algæ in the formation of the Sprudelstein of Carlsbad and other calcareous rocks"; that "Bornet, the French algologist, had insisted no less strongly on the work done in perforation and breaking up of calcareous fragments by other plants"; Prof. Judd "was inclined to regard some of the structures as due to the action of destructive rather than to constructive organisms."

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A series of interesting experiments has lately been made on some of the French railways with the use of inclined planes, or "air-ploughs," for the purpose of lessening the air resistance experienced by trains. We are told that by means of such an apparatus a saving of coal, amounting in some cases to 8 or even 12 per cent., has been effected, but something must be deducted for the excellence of the engine and its driver. We are rather puzzled as to how M. Ricour makes the slanting planes "*four* in *three*," since, even if they were *vertical*, they would only be at an incline of one in one! Still, as we are informed that the Paris, Lyons, and Mediterranean Company has had forty engines fitted with these planes, the invention seems to be something more than a mere theoretical speculation.

NUTRITIVE VALUE OF SUGAR. (By N. Zuntz, *Chem. Centr.*, 1895, I., 691—692, from *Zeit. ver. Rübenzuck.*, 1894, 64, 71).—By causing a dog to mount continuously a plane inclined at 10″ to the horizon, and analysing the expired air, it is possible to calculate the amount of oxygen used per kilogram-metre of work done, and also the quantity of heat produced by the combustion in which this oxygen took part. The amount of oxygen used per kilogram-metre of work done was found to be, for a diet of lean meat, 0·57 c.c. (0·58 Cai.); fat, 0·53 c.c. (2·43 Cal.); cane sugar, 0.54 c.c. (2·58 Cal.). Sugar, fat, and lean meat have thus about the same power of enabling physical exertion to be sustained. The efficiency of the animal body, considered as a machine, was found to be about one-third, whereas with steam-engines only one-twentieth to one-fifth of the energy of the fuel is obtained as mechanical work.

CAN NON-LEGUMINOUS PLANTS FIX FREE NITROGEN? By F. Nobbe and L. Hiltner (*Landw. Versuchs-Stat.*, 45, 155—159). —After it was established that *Leguminosæ*, when suitably infected with nodule bacteria, have the power of assimilating free nitrogen, the authors showed that under similar conditions the same holds good with *Elæagnas* and with the white and black alder. *Podocarpus*, a conifer, which also has root nodules, seems likewise to have the power of fixing nitrogen. The same property has recently been frequently attributed also to non-leguminous plants, which have no root nodules, the evidence being that the final nitrogen in the plants and soil was greater than the initial nitrogen in the seeds and soil.

HEAT OF THE SUN.—In an article in the June (1895) number of the *Astrophysical Journal* by H. Ebert, he concludes that the temperature of the interior region of the sun is in round numbers 40,000° C. This is in good agreement with values previously determined by others.

We shall be pleased to insert Exchange Notices without charge for our readers.—*Editor*.

Reviews.

Modern Microscopy : A Handbook for Beginners. By H. I. Cross and Martin J. Cole. Second edition. 8vo, pp. 182. (London: Bailliere, Tindall, and Cox. 1895.) Price 3/6.

This very useful book consists of two parts :—I.—The Microscope, and Instructions for its Use, by M. I. Cross ; II., Microscopic Objects : How Prepared and Mounted, by Martin J. Cole. The subject matter in both cases has been thoroughly revised, and much additional information given on the methods of manipulation. The beginner will find this a most useful book.

A Popular Handbook to the Microscope. By Lewis Wright. Cr. 8vo, pp. 256. (London : Religious Tract Society. 1895.) 2/6.

This is a very useful, cheap, and well illustrated little book. It is divided into 13 chapters, and treats of Rays, Images, and Lenses ; Practical Optics of the Microscope ; the Simple Microscope and its uses ; the Compound Microscope and Accessories ; Microscope Manipulation, Microscopical Drawing, Measurement, and Photography ; Manipulation, Preparation, Mounting, and Selection of Objects, etc. etc. There are 186 illustrations.

Hidden Beauties of Nature. By Richard Kerr, F.G.S. Crown 8vo, pp. 256. (London : Religious Tract Society. 1895.) Price 3/6.

The chapters in the book before us contain in simple language the main points of lectures delivered to Scientific Societies, Colleges, etc., and to large audiences in various parts of England ; and are well calculated to help the reader to take up some department of Nature as a definite study. The chapters treat of The Study of Nature ; How to Begin ; Sea Urchins ; the Euplectella ; Atlantic Ooze ; Radiolaria ; Diatoms, etc. etc. There are several plates and nearly sixty illustrations.

Nature's Story : Science Talk to Young Thinkers. By H. Farquhar, B.D. Crown 8vo, pp. 191. (Edinburgh and London : Oliphant, Anderson, and Ferrier. 1895.) Price 2/6.

The author attempts here to bring some of the latest results of science within the range of young readers, and hopes to interest them in the long and wonderful life-history of the commonest things ; the titles of some of the chapters being Flowers, Leaves, Fruit and Seed, The Dispersal of Seed, Protective Colours, Warning Colours, etc. It is nicely illustrated.

Some Common Insects and other Lowly Forms. By Emily Dibden. Crown 8vo, pp. 148. (London : James Nisbet & Co. 1896.) 1/6.

An interesting and instructive book for young people. It treats of Insect Cities ; Insect Homes—viz., Wasp Tower, Bee House, Spider Castle, and Caterpillar Tent ; Our Water-Butt and its Inhabitants ; The Silver Pond and what we found there ; Household Foes—viz., the Spider, the Fly, the Cockroach, the Clothes Moth, and the Ant. There are several good illustrations.

A Handbook to the Birds of Great Britain. By R. Bowdler Sharpe, LL.D. Vol. II. Crown 8vo, pp. xviii.—308. (London : W. H. Allen and Co. 1896.) Price 6/-

To the list of British Birds two species have been added since the publication of the first volume a few months ago—viz., the Sub-Alpine Warbler

(Sylvia subalpina) and Coues Redpole *(Cannabina exilipes)*. This volume of *Allen's Naturalist's Library* contains twenty-seven beautifully coloured plates, besides a number of illustrations in the text. These books are thoroughly readable and full of information. We congratulate the author on their production.

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A HANDBOOK OF BRITISH LEPIDOPTERA. By Edward Meyrick, B.A., F.Z.S., F.E.S., etc. Cr. 8vo, pp. vi.—843. (London: Macmillan and Co. 1895.) Price 10/6 net.

This work is designed to enable the student of British Lepidoptera to identify his specimens with accuracy, and also to acquire such general knowledge of their structure and affinities as ought to be possessed by every worker. The structural characters are, in every instance, drawn from the author's own observations, illustrations being given of the wing neuration of the different genera, and, in many cases, species. In the appendix is a classified list of the better-known Food plants with English names. There is also a voluminous index.

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BRITISH AND EUROPEAN BUTTERFLIES AND MOTHS (Macrolepidoptera). By A. W. Keppell, F.L.S., F.R.S., etc., and W. Egmont Kirby, L.S.A., etc. 4to, pp. xvi.—273. (London: Ernest Nister.) 25/-

This grand work contains a description of most of the Macrolepidoptera inhabiting Central Europe, and nearly all of those of the British Isles are described or figured. All the British species have English names assigned to them. In the introduction the Anatomy of Lepidoptera is described with instructions for collecting Butterflies and Moths, and Larvæ and Pupæ, and for setting for the cabinet. The average expanse of the wings in inches will be found after the names in the Index of Latin Names. There are 30 very beautifully coloured plates. The book is handsomely bound.

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THE ELEMENTS OF NATURAL SCIENCE. Part I., BOTANY. By Dr. H. Wettstein. 8vo, pp. xii —106. (London: O. Newmann. 1894.)

This book presents the subject-matter in such an arrangement that an expansive treatment of it is possible, and it gives the most needful points of support for undisturbed progress after oral instruction. It treats of the development of the young plant from the seed. The work will be completed in five parts. There are 155 illustrations.

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DIE NATURLICHEN PFLANZENFAMILIEN. By A. Engler. Nos. 123—125. (London: Williams and Norgate. Leipzig: Wilhelm Engelmann. 1895.)

These parts contain the completion of the Asclepiadaceæ, by K. Schumann; they also form the completion of the fourth volume of this grand work. There is a fine heliogravure plate and 31 illustrations, comprising 299 figures.

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INTRODUCTION TO THE STUDY OF FUNGI: Their Organography, Classification, and Distribution for the Use of Collectors. By M. C. Cooke, M.A., LL.D., A.L.S., etc. etc. 8vo, pp. x.—360. (London: A. and C. Black. 1895.) Price 14/-

Owing to the rapid advance in the knowledge of the life-history and development of the Fungi during the past ten years, and especially the large scheme of classification carried out by Prof. Saccardo, it is essential that a guide and introduction should be prepared and published for the use of students, which should treat the subject more after the manner of a text-book, adapted to the illustration of recent discoveries, and an explanation of the methods of classification. As such, we feel sure the volume will be welcomed by the student. There are 148 illustrations, glossary, and index.

An Introduction to the Study of Seaweeds. By George Murray, F.R.S.E., F.L.S., etc. Crown 8vo, pp. xvi.—271. (London: Macmillan and Co. 1895.) Price 7/6.

Modern research has completely changed the whole aspect of the study of seaweeds. In the work before us the author has described only what he has personally verified by examination, or by the inspection of the original account. The arrangement of the sub-classes is in the following order:—The *Phæophyceæ*, with its familiar forms of sea-wracks and tangles form the first sub-class; the *Chlorophyceæ* and *Diatomaceæ* follow; the *Rhodophyceæ* next make a series by themselves; and lastly, the simple *Cyanophyceæ*. There are eight beautifully coloured plates and eighty-eight other illustrations.

Handbook of Grasses. By William Hutchinson. Cr. 8vo, pp. 92. (London: Swan Sonnenschein & Co. 1895.) Price 2/6.

Treats of the Structure, Classification, Geographical Distribution, and Uses of Grasses. It also describes the British Species and their Habitats, and is an endeavour to popularise the study of grasses, the peculiarities of their structure, and terms employed in describing these plants are carefully explained; the chapter descriptive of the British species and their habitats is arranged with special regard to convenience in field work. Definite information is also given regarding the geographical distribution of grasses and their vast economic importance. A very useful book. There are 40 good illustrations in the text.

Analytical Key to the Natural Orders of Flowering Plants. By Franz Thonner. Cr. 8vo, pp. 151. (London: Swan Sonnenschein and Co. 1895.) Price 2/-

In this work the author chooses, for the determination of genera, distinctive features, preferring those which are visible to the naked eye at the time of flowering.

Ferns: British and Foreign. By John Smith, A.L.S. New and enlarged edition. Cr. 8vo, pp. xv.—450. (London: W. H. Allen. 1895.) Price 7/6.

This useful work gives the history, organography, classification, and enumeration of the species of garden ferns, with a treatise on their cultivation—*e.g.*, Special or pot cultivation; Natural cultivation; Wardian-case cultivation and propagation. There are also a General Index of Genera, Species, Synonyms, and an Index of Special Terms, and a great number of illustrations.

Random Recollections of Woodland, Fen, and Hill. By J. W. Tutt, F.E.S. Second edition. Crown 8vo, pp. 256. (London: George Gill and Sons. 1895.) Price 2/6.

Mr. Tutt has given us a delightfully written little book dealing with natural history subjects and country scenery. We can cordially recommend it as a reading book for our young friends, and trust it will lead many of them to observe for themselves some of the wonderful things in Nature by which we are surrounded. There are more than 100 good illustrations.

Half-Hours with the Stars. By Richard A. Proctor, B.A., F.R.A.S., etc. New edition, revised and corrected. 4to. (London: W. H. Allen. 1896.) Price 3/6.

We have, to give the full title, A Plain and Easy Guide to the Knowledge of the Constellations, showing in 12 maps the position of the principal star-groups night after night throughout the year, with introductions and a separate explanation of each map for every day in the year. The maps are very good, and so plain that we believe the student could not possibly misinterpret them, even if he paid no attention to the accompanying letterpress.

Great Astronomers. By Sir Robert S. Ball, D.Sc., LL.D., F.R.S., etc. 8vo, pp. xii.—372. (London: Isbister and Co. 1895.) 7/6.

In the handsome work before us the author has presented the life of each astronomer in such detail as to enable the reader to realise in some degree the man's character and surroundings, and has indicated the main features of the discoveries by which he has become known. The illustrations are good.

The Zoo (Fourth Series). By the Rev. Theodore Wood, F.E.S. 4to, pp. 96. (London: Society for Promoting Christian Knowledge. 1896.) Price 2/6.

Treats of a great number and variety of water-loving Birds and Reptiles. There are plain and coloured illustrations. This is just the book for the young naturalist.

Charles Lyell and Modern Geology. By Prof. T. G. Bonney, D.Sc., LL.D., F.R.S., etc. Cr. 8vo, pp. 224. (London: Cassell and Co. 1895.) Price 3/6.

In this work the author shows how Charles Lyell studied, how he worked, how he accumulated observations, and how each journey had its definite purpose. The author quotes freely from Lyell's letters, diaries, and books, thus showing how things presented themselves to his eyes and how ideas were maturing in his mind.

Electricity for Students. By Edward Trevert. Cr. 8vo, pp. 128. (Lynn, Mass., U.S.A.: Bubier Publishing Co. 1895.)

This is a popular treatise, giving in brief and simple language the theory and practical application of electricity up to date. Some entertaining experiments are given, combining theory with practice.

The Story of the Earth in Past Ages. By H. G. Seeley, F.R.S., etc. 12mo, pp. 196. (London: George Newnes. 1895.) Price 1/-

We are very pleased with this little series of "Stories," of which this is the fourth it has been our privilege to notice. In the one before us explanations are given of the nature of the common materials which form rocks, of the ways in which they rest upon each other, and of the means by which they may be distinguished. There are 40 illustrations.

The Splash of a Drop. By Prof. A. M. Worthington, M.A., F.R.S. Fscap. 8vo, pp. 76. (London: Society for Promoting Christian Knowledge. 1895.) Price 1/6.

A reprint of a Discourse delivered at the Royal Institution of Gt. Britain, May 18th, 1894. Without carefully reading this interesting little volume, one of the "Romance of Science" series, it is impossible to form an idea of how much interest can be got out of so simple an act as the "Splash of a Drop."

Popular Readings in Science. By John Gall, M.A., LL.B., and David Robertson, M.A., LL.B., B.Sc., etc. Second edition. Cr. 8vo, pp. 467. (Westminster: A. Constable and Co. 1895.) Price 4/-

A thoroughly readable and instructive book, in which is presented to the reader, in a popular form, some of the more important results of Scientific research, prominence being given to those which have been arrived at in the course of scientific discovery rather than to the methods by which the results have been reached. There are a number of engravings in the text.

AN ELEMENTARY TREATISE ON HEAT. By Balfour Stewart, LL.D., F.R.S., etc. Sixth edition, revised; with additions by Robert E. Baynes. Cr. 8vo, pp. xxiv.—476. (Oxford: The Clarendon Press. 1895.) Price 8/6.

We have here the facts and principles of the Science of Heat. The author begins with the study of well-ascertained facts, and proceeds onwards to general principles. The work is divided into three parts. The first embraces the study of the various effects produced by heat upon bodies; the second contains the laws which regulate the distribution of heat through space, and includes radiation, conduction, convection, and the measurements of specific and latent heat; the third relates to the nature of heat, its source and connection with other properties of matter. In this sixth edition articles have been added on the radio-micrometer, bolometer, and steam calorimeter, and on the direct determination of the specific heat of gases at constant volume.

A MANUAL OF PHYSICS; being an Introduction to Physical Science. By William Peddie, D.Sc., F.R.S.E. Second edition. Cr. 8vo, pp. xvii.—573. (London: Bailliere, Tindall, and Cox. 1896.) Price 7/6.

The author intends this book to be an accompaniment to a course of lectures on physics, by the use of which a student may largely avoid the evils of note-taking, and give more attention to the words of his teacher.

THE FORCES OF NATURE: A Study of Natural Phenomena. By H. B. Harrop and L. A. Wallis. Crown 8vo, pp. 159. (Columbia, Ohio, U.S.A.: Harrop and Wallis. 1895.)

The authors describe in a very simple manner The Solar System; The Atmosphere and Sound; Chemistry and the Structure of Matter; Radiant Energy, Light, Heat, and Actinism; Electricity and Magnetism. The illustrations are not nearly so distinct as they should have been.

FIRST-STAGE MECHANICS. By F. Rosenberg, M.A. Cr. 8vo, pp. viii.—296. (London: W. B. Clive. 1895.) Price 2/-.

This book is designed to cover the requirements of the Elementary Stage of the Science and Art Department in the Theoretical Mechanics of Solids. Numerous "observations," "cautions," and illustrative examples, have been given in order to prevent the student coming to a standstill when help of the teacher is not available, and are intended also to provide against common mistakes.

THE LANTERN and How to Use it. By C. Goodwin Norton. Cr. 8vo, pp. iv.—136. (London: Hazell, Watson, & Viney. 1895.) 1/-

This is No. 10 of "The Amateur Photographers' Library," and treats very thoroughly of the Magic Lantern, the various methods of Illumination, Single, Double, and Triple Lanterns, Lantern Slides, and the management of Lantern Exhibitions. There are a number of illustrations.

INDUSTRIAL EXPLORATIONS. By R. Andom. With nearly one hundred illustrations by T. M. R. Whitwell. Cr. 8vo, pp. xv.—295. (London: J. Clarke and Co. 1895.) Price 3/6.

A very amusing and instructive book. The explorations take the reader into Piano-land, Rope-land, Tram-land, Candle-land, Gas-land, Paper-land, Soap-land, Pottery-land, Match-land, Rubber-land, Wire-land, & Sweet-land; a good account being given of the various manufactories visited.

ANNUAL OF THE UNIVERSAL MEDICAL SCIENCES: A Yearly Report of the Progress of the General Sanitary Sciences throughout the year. Edited by Charles E. Sayons, M.D., and Seventy Associate Editors assisted by over Two Hundred Corresponding Editors, Collaborators, and Correspondents. Illustrated with Chromo-lithographs, Engravings, and Maps. 5 vols., large 8vo. (Philadelphia: The F. A. Davis Co. London: F. J. Rebman. 1895.)

The eighth annual issue of this voluminous and now well-known work has just come to hand, and as usual contains a great number of very important papers. Prof. Wilson, of Philadelphia, has contributed a fine paper on the Lungs and Pleura. Other papers of considerable importance are by Prof. L. C. Gray and Drs. Pritchard and Shultz on Diseases of the Brain; Prof. Obersteiner on Diseases of the Spinal Cord; Prof. Rubino, of Naples, on Diseases of the Stomach, Liver, and Pancreas. The article by Dr. Dujardin-Beaumetz on General Therapeutics and Pharmaceutical Chemistry is exceedingly good. The entire work is divided into sixty-two sections, and the letterpress, plates, illustrations, and binding are as good as could possibly be desired.

PHYSIOLOGY. By A. Macalister, LL.D., M.D., F.R.S., F.S.A., etc. 12mo, pp. 123. (London: Society for Promoting Christian Knowledge. 1895.) Price 1/-.

One of the "Manuals of Elementary Science" Series, and gives in a simple and concise form some of the elementary principles of the Physiology of Man. The information contained will assist those who desire to know something of the nature of the parts of their own bodies, and their several functions.

SIMPLE METHODS FOR DETECTING ADULTERATIONS. By John A. Bower. Cr. 8vo, pp. 118. (London: Society for Promoting Christian Knowledge. 1895.) Price 2/-.

This useful little book contains a series of samples for experiment, and another for observation. The experiments are simple, and consist principally in the application of chemical tests. The observations require the use of the microscope. The directions in the book refer only to the simplest methods of detecting adulterations. There are 36 very good illustrations.

AIDS TO THE ANALYSIS OF FOOD AND DRUGS. By T. H. Pearmain and C. G. Moor, M.A., F.C.S. 12mo, pp. 160. (London: Bailliere, Tindall, and Cox. 1895.) Price 3/6.

This book, which is of convenient size for the pocket, will doubtless be found useful by those who are engaged in the examination of food and drugs. It gives instructions for the analysis of most of the common articles of food, such as Milk, Cheese, Bread, Flour, Tea, Coffee, Cocoa, various Spices, etc.

HELPS TO HEALTH and Beauty. By a Pharmaceutical Chemist. Post 8vo, pp. 117. (London: James Clark & Co. 1895.) Price 1/-.

We have here two hundred recipes, all of which appear to be of a very practical and useful character.

ARNOLD'S PUPIL TEACHER'S BOOK OF MEMORY MAPS. Divisions 1, 2, and 3. Long 4to. (Leeds: E. J. Arnold.) Price 1/4 each.

Maps in ordinary use are too much crowded with names and details to serve as good copies for those who are only learning geography. The object of this series of Maps is to provide copies suitable for Memory work, which will bring into prominence only important features and altogether suppress unimportant ones.

THE DISEASES OF THE WILL. By Th. Ribot. Translated from the eighth French edition by Merwin-Marie Snell. Cr. 8vo, pp. vi.—134. (Chicago: The Open Court Pub. Co. 1894.)

In treating of the diseases of the will, the author proposes to study its anomalies, and to draw from this study conclusions regarding its normal state. At the conclusion of this study he shows that in every voluntary act there are two entirely distinct elements: one, the state of consciousness; the other, a very complex psycho-physiological mechanism in which alone resides the power to act or to restrain.

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THE ORIGIN AND NATURE OF MAN. By S. B. G. McKinney. Cr. 8vo, pp. 95. (London: Elliot Stock. 1895.) Price 3/6.

This little book is divided into two parts: I., Analysis; II., Intuition. The following is one of the concluding remarks of the author: "If we trust to evolution to teach us the origin of man, we must for ever wander in pursuit of indefinite phantoms among an infinite variety of descending forms, ignorant of any object or function to justify our existence, and with no hope of certain knowledge regarding either our past condition or concerning our future state."

———

LE CURE DU BENIZOU, avec Illustrations Photographiques D'Aprês Nature. 4to, pp. 30. (Paris: Gauthier-Villars et Fils. 1895.)

The object of this book is doubtless primarily to show the fine photographic reproductions of various scenes in the life of the Priest of Benizou. The surroundings of his sphere of labour and the unique personality of this octogenarian have afforded the artist excellent opportunities for a trial of his skill. Apart from the very beautiful pictures, the letterpress and paper are admirable.

———

THE ROSE-BUD ANNUAL. 4to, pp. viii.—192. (London: Jas. Clarke and Co. 1896.) Price 4/-

Nearly 250 capital illustrations, and a great number of funny and interesting stories, besides poetry and music, which cannot fail to amuse the little ones.

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DOWN THE VILLAGE STREET. By Christopher Hare. Cr. 8vo, pp. 334. (Edinburgh and London: W. Blackwood and Sons. 1895.) 6/-

This is a charming book, and gives in a most interesting manner eight scenes in one of our West of England Hamlets. The characters are undoubtedly drawn true to life, and will be read with interest and profit.

———

THE APOCRYPHA. Crown 8vo, pp. 147. (London: Samuel Bagster and Sons.) Price 2/-

As we never find the Apochrypha bound up with our modern Bibles, we have no doubt this little book will be gladly welcomed by many readers. We regret to notice that it is printed in type rather too small for old eyes to see with comfort.

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THE ILLUSTRATED GUIDE to Great Yarmouth, including Southtown, Gorleston, Norwich, Lowestoft, Southwold, and Cromer. Cr. 8vo, pp. 133. (London: Jarrold and Son.)

This little illustrated guide gives a full description of the East Anglian Broads and also of the River Fishing.

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THE BRITISH AND COLONIAL Druggist's Diary, 1896. 4to. (London Office.)

Besides a useful interleaved diary, in which a page is allotted to each week, we find a Dictionary of Terms used in Disease; a Table of the Average Height and Weight of Man; a Table of Poisons and Antidotes; Veterinary Posology; and Dental Notes.

THE CHEMIST'S AND DRUGGIST'S DIARY, 1896. 4to. (London: 42 Cannon St.)

This well-known annual contains, besides the diary (an interleaved page for every week in the year, much useful information. Amongst other articles we notice one on How to Push Trade, with hints and formulæ for articles suitable for every month in the year; How to Treat Diseases; and a number of others specially useful to those in the trade.

THE BOY SKIPPER; or, "I have only done my duty." By William Charles Metcalfe. Cr. 8vo, pp. 264. (London: Jarrold and Son. 1895.) Price 3/6.

This is an interesting and true account of the hero, William Shotton, who served for over two years as an apprentice to Captain J. H. Hunter on board the *Trafalgar*, and under whose able tuition he acquired so much of that sound practical knowledge of his profession, which stood him in such mighty stead during the terrible voyage from Java to Melbourne. The illustrations are good, the frontispiece being a portrait of William Shotton.

QUEEN VICTORIA'S DOLLS. By Frances H. Low. Illustrated by Alan Wright. 4to. (London: George Newnes. 1894.) Price 5/-.

Here are nicely coloured pictures representing 75 of Queen Victoria's dolls, with descriptive letterpress. "The dolls dressed by Her Majesty are for the most part theatrical personages and court ladies, and include also three males (of whom there are only some seven or eight in the whole collection) and a few little babies, tiny creatures, made of rag, with painted muslin faces. . . An hour spent among the dolls that Queen Victoria played with as a child is not only a liberal education in the evanescent influences and fashions of the early part of this century, but an abiding study of her imaginative fancy."

EVERYBODY'S Illustrated Book of Puzzles. 8vo, pp. 122. (London: Saxon and Co.) Price 1/-.—Very amusing and entertaining.

THE TALLERMAN-SHEFFIELD Patent Localized Hot-Air Bath. 8vo, pp. 51. (London: Bailliere, Tindall, and Cox. 1895.)

Describes a new Invention for the Treatment of Rheumatism, Gout, Rheumatic Arthritis, Stiff and Painful Joints, Sprains, etc., by the local application of super-heated Dry Air, with Notes of cases treated at St. Bartholomew's Hospital, North-West London Hospital, Charing-Cross Hospital, St. Mary's Hospital, The Royal Portsmouth Hospital, and elsewhere.

ON MEMORY and The Specific Energies of the Nervous System. By Prof. Ewald Hering. Cr. 8vo, pp. 50. (Chicago: The Open Court Publishing Co. 1895.)

A NEW ENGLISH DICTIONARY on Historical Principles. Edited by James A. H. Murray, Vol. III., DEPRAVATIVE—DEVELOPMENT; Vol. IV., FEE—FIELD. By Henry Bradley, Hon. M.A. Oxon. (Oxford: The Clarendon Press. London: Henry Frowde. 1895.) Price 2/6 each.

These two parts, which were published simultaneously in October, contain 3073 words and nearly 16,000 illustrative quotations. This will unquestionably be when completed the most important dictionary ever published.

Hazell's Annual for 1896 : A Cyclopædic Record of Men and Topics of the Day. Edited by W. Palmer, B.A. Cr. 8vo, pp. 678. (London : Hazell, Watson, and Viney. 1896.) Price 3/6.

This is the eleventh year of issue of this valuable Annual, which contains many new features, amongst which we notice an able article on Factory and Workshop Legislation, which embraces a summary of the whole body of Factory Legislation. We find also articles upon the Royal Commission and Committees on Secondary Education, Joint Stock Companies, Opium, Indian Finance, Poor Law Administration, and Prison Reform. Political events and changes are fully descrlbed. We have Biographies of the Members of the New House of Commons and the Pollings in the various Constituencies corrected up to date. Four new Maps of Indo-China, the Valley of the Upper Nile, the Pamirs, and Sierra Leone, have been added ; making the Annual one of the most up-to-date publications of the day.

The Oracle Encyclopædia, containing most accurate information in the most readable form. (London : Geo. Newnes.) 6d. net.

This is an exceedingly cheap and most useful publication. Each part contains 120 large pages, 11 by $7\frac{1}{2}$ in., and is well illustrated. No. 7, which commences the second volume, opens with Chas. V. and goes on to Columba, St.

The Royal Natural History. Edited by Richard Lydekker. (London : F. Warne and Co.) Price 1/- net.

This fine work has reached to Part 26. In Part 25, commencing the 5th volume, the section treating of the Reptiles was begun, and treats of Crocodiles, Tortoises, and Turtles ; Lizards and Chameleons ; and Snakes. There are two beautiful coloured plates, and a number of engravings in each number.

Science Progress : A Monthly Review of Current Scientific Investigation. Conducted by Henry C. Burdett ; edited by J. Bretland Farmer, M.A. Price 2/6, or 25/- per year, post free.

The December part of this important periodical contains : Williamson's Researches on the Carboniferous Flora ; Mineral Transformations ; On some Applications of the Theory of Osmotic Pressures to Physiological Problems, part I. ; Theories of Electrolyses ; The Study of the Ancient Sediments ; Carl Ludwig ; Notices of Books ; and Chemical Literature for October.

European Butterflies and Moths. By W. F. Kirby, F.L.S., F.E.S., etc. Based upon Berge's Schmetterlings-Buch. Nos. 17, 18, 19. (London : Cassell and Co.) 6d. each.

Each part contains a fine coloured plate and 8 pages of letterpress. Those before us describe the following families of the Sphingidæ, viz. :—i., *Sphingidæ* ; II., *Thyrididæ* : III., *Sesiidæ* ; IV., *Zygænidæ* ; and the first family of the Bombyces—viz., *Lithosiidæ*.

The Story of the Heavens. By Sir Robert S. Ball. Parts II. and III. (London : Cassell and Co.) Price 6d. each.

We are glad to find that this most interesting work is being published in so cheap a form. These numbers treat of the Sun, the Moon, and the Solar System.

SCIENCE FOR ALL. Edited by Robert Brown, M.A., Ph.D., F.L.S., F.G.S., etc. (London: Cassell and Co.) Price 6d. monthly.

The first part of this marvellously cheap and instructive periodical is to hand. Amongst other interesting articles we notice the following:—The Man in the Moon; A Piece of Limestone; A Fallen Leaf; Ice, Water, and Steam; How Electricity is Produced; a Piece of Sponge, etc. etc. Paper, type, and illustrations are good. Each part will contain 96 crown 8vo pages and some 80 or 90 illustrations.

BATTLES OF THE NINETEENTH CENTURY. (London: Cassell and Co.) Price 7d. monthly.

The tenth (December) part of this work gives accounts of Garibaldi at the Battle of the Volturno; Vittoria; Buena Vista; The Expedition to Egypt in 1801; The End of the Zulu War; Solferino; and Mudki and Firozshah. Each part is well illustrated; consists of 64 pages, and a frontispiece.

LITTLE FOLKS. (London: Cassell and Co.) 6d. monthly.

At the moment of going to press we received the part for January, 1896. This part commences a new and enlarged series and is full of stories, poetry, and pictures which cannot fail to amuse the little folk. With this part is presented a prettily coloured pictorial calendar.

CHUMS. (Cassell and Co.) 6d. Monthly.

This popular monthly needs no word from us; every boys says, "*Chums* is an awfully jolly paper."

CATALOGUE of the Adhesive Postage and Telegraph Stamps, Post-marks, and Obliterations of the United Kingdom. Compiled and published by H. L'Estrange Ewen, Swanage, Dorset. No. 4. Price 1/6.

THE ENGLISH SPECIALISTS' JOURNAL. Nos. 1 and 2. By the same. Price 6d. each.

Mr. L'Estrange Ewen has discovered varieties and peculiarities in our English stamps which many extensive collectors appear totally to have overlooked. He tells us the *Specialists' Journal* will be published next year at 4/- the year, post free.

On some Protein Crystalloids and their Probable Relation to the Nutrition of the Pollen-Tube.

By Lily H. Huie, Hollywood (Edinburgh).

Plate V.

BY the use of special fixing and staining methods, Zimmerman* has, during the last few years, greatly extended our knowledge of Protein Crystalloids; and Stock,† using the same methods, has recently investigated their relation to the metabolism of the plant. Apart altogether from those found in aleurone grains, Protein Crystalloids may be classified according to their position in the cell as—

1.—Nuclear Crystalloids.

2.—Cytoplasmic Crystalloids.

3.—Cell-sap Crystalloids.

4.—Chromatophoric Crystalloids.

Nuclear Crystalloids.—Zimmermann has found that, in the nuclei of Pteridophyta and Angiosperms, Protein Crystalloids are of much more frequent occurrence than was formerly supposed. He has found them in a very large number of Ferns and in 47 species of Phanerogams belonging to ten different families.

Cytoplasmic Crystalloids occurring in the body of the cell have been demonstrated only in a very limited number of instances. Much difficulty has been experienced by observers in determining whether such crystalloids really occur in the cytoplasm or in the cell-sap, because of the thickness of their sections. Up till now, in one instance only—that of the potato tuber—have protein

* Zimmermann, *Beitrage zur Morphologie und Physiologie der Pflanzenzelle*, Heft I., p. 54, and Heft II., p. 112.

† Stock, *Ein Beitrag zur Kenntniss der Proteinkrystalle*; Cohn's *Beitrage zur Biologie der Pflanzen.*, Bd. 6, 1892.

crystalloids been proved to be in the cytoplasm. Those which form the subject of the present paper are also cytoplasmic, and are found in *Scilla patula*, etc.

Cell-sap Crystalloids.—Under this head it is convenient to group all other known instances of crystalloids occurring in the body of the cell (11 in all, according to Zimmermann), since, with the exceptions just mentioned, whenever their true position has been investigated, they are said to have been found in the Cell-sap.

Chromatophoric Crystalloids.—Schimper * has already carefully studied the protein crystalloids of Chromatophors, and enumerated the instances of their occurrence, and Zimmermann has extended his researches in this direction.

Methods.

Former methods.—Zimmermann and Stock fix the material preferably in a saturated solution of corrosive sublimate in absolute alcohol; embed in paraffin and cut sections, which vary in thickness from 5 to 10 μ. The sections are left for twenty-four hours or more in a 0·2 per cent. solution of Säure-fuchsin in distilled water; washed out in running water until sufficiently decolourised; dehydrated with absolute alcohol, cleared up in xylol, and mounted in xylol-balsam.

Though both histologists have endeavoured to find other methods for the successful demonstration of these bodies, they have not succeeded in doing so, and come to the conclusion that Säure-fuchsin acts as a specific stain.

My methods.—The ovaries of *Scilla patula* were fixed by me in three different ways :—

1.—In absolute alcohol.

2.—In Mann's Picro-corrosive Alcohol,† which consists of a saturated solution of corrosive sublimate and picric acid in absolute alcohol.

3.—In Mann's Watery Corrosive Fluid.‡

* Schimper, *Untersuchungen über die Chlorophyllkörper, und die ihnen homologen Gebilde*, Pringsheim's Jahrbuch, Bd. 16, p. 1.

† Mann, *Trans. Bot. Soc. Edin.*, vol. XVIII., pp. 429, 432, 1890.

‡ *Journ. Scot. Micro. Soc.*, 1894, p. 155.

To a boiling 0·75 per cent. common salt solution, sublimate is added to saturation (12 grm. for 100 cc.). The solution is then allowed to cool, when crystals of sublimate make their appearance. Preserve the solution without decanting (M. Heidenhain).

Martin Heidenhain's corrosive sublimate solution, 100 cc. :—

Picric Acid	1 grm.
Tannic Acid	1 grm.

(The Tannic Acid may be omitted if preferred.)

Material fixed in absolute Alcohol gives, however, poor results with the stain I employed, and requires very great care in the decolourising process. The picro-corrosive alcohol gives much better results, but the material which stained most successfully was fixed by the watery picro-corrosive.

The tissues were carefully dehydrated, and taken through Chloroform into Paraffin, and serial sections cut not thicker than 2—3 μ. Sections of this thinness permit the exact position and the details of the conglomerate crystalloids to be determined with the greatest facility.

The paraffin sections were spread out on warm water (40—45° C.), after Gulland,* and fixed to the slide by Mann's albumen method,† and then stained in Mann's Methylblau-Eosine mixture as follows :—

Requisites :—The Staining Fluid.

a.—1 per cent. methylblau in distilled water ...	35 cc.
1 per cent. water-soluble eosin in distilled water	45 cc.
Distilled water	100 cc.

b.—1 per cent. caustic soda solution in absolute alcohol.

The Methylwasserblau (C_{37} H_{26} N_3 S_3 O_9 Na_3) was obtained from Dr. Grübler, Leipzig.

Method :—

1.—Stain for twenty-four hours.

2.—Rinse the dark blue sections in ordinary water.

3.—Dehydrate thoroughly with absolute alcohol.

* Gulland, *Journ. of Anat. and Physiol.*, 1891, p. 56.

† Mann, "A New Fixing Fluid for Animal Tissues," *Anat. Anz.*, Jahrg. VIII., 1893, Nos. 12—13, p. 442, and *Journ. Scottish Micro. Soc.*, 1894, p. 161.

4.—Transfer the slide to a vessel containing absolute alcohol, 30 cc., and 1 per cent. caustic soda solution in absolute alcohol, 4 drops. Wait till sections are of a rust colour.

5.—Remove all traces of caustic soda with absolute alcohol.

6.—Rinse sections in ordinary water for one minute. Red clouds are given off and the sections become bluish.

7.—Place slides for two minutes into water slightly acidified with acetic acid. This is done to deepen and fully restore the blue colour and also to fix the eosin.

8.—Dehydrate, clear with xylol, not clove oil, and mount in turpentine-balsam.

For results see Figs. 1—14.

By using simply a $\frac{1}{2}$ per cent. watery solution of eosin, and decolourising with alcoholic caustic soda in the way detailed above, I succeeded in staining the crystalloids, but the result is inferior to that produced by the contrast of the double stain. Other acid dyes were tried with less success, Magdala-rot (echt) giving the next best results.

I have used Mann's stain for the crystalloids in the aleurone grains of the seeds of *Ricinus*, with beautiful results. I have also examined the tissues of various plants in which Zimmermann finds protein crystalloids, both with Mann's stain and with the Säurefuchsin, with the result that whenever I succeeded with the one method in demonstrating them, I succeeded also with the other ; and whenever I failed with the one stain, I failed equally with the other.

Comparing Zimmermann's method with the one I employed, I certainly prefer the latter because of the great preciseness with which crystalloids are stained.

Cytoplasmic Crystalloids of Scilla patula and Hyacinthus Sp.

While examining the ovaries of *Scilla patula* with the help of the Methylblau-eosin double-stain, my attention was arrested by numbers of bright red granules and crystalloid bodies in the cytoplasm of the unicellular hairs, that occur in considerable numbers on the placentas in this and other species of *Scilla*. From their resemblance to many of Zimmermann's figures, it at once occurred

to me that these bodies were protein-crystalloids. Proceeding to test them I found—

They have a higher refractive index than the cytoplasm.

Iodine colours them darkly.

By Zimmermann's method of staining they were well shown, but not unless the sections were of a thickness of at least 7 μ, which is a disadvantage for minute cytological work.

The hairs in which the crystalloid bodies occur are extremely numerous immediately above the uppermost ovules, and are more sparsely distributed on the lower portion of the placenta.

I have studied them from the time when they are first differentiated from the surrounding epidermal cells, till the withering of the flower, when they degenerate. In *young ovaries (about three millemetres in length*, including the pistil), the upper ovules of which show four nuclei in the embryo-sac, the hairs are only slightly larger than the other epidermal cells (Fig. 1, *a*), and are not specially rich in cell protoplasm, although the nucleus stains deeply.

In *ovaries five millemetres long*, at the time when the embryo-sac first contains eight nuclei, the hairs have elongated greatly and are remarkably rich in protoplasm, and in nuclear chromatin, and, with few exceptions, each hair possesses several (2—6) nucleoli (Figs. 2 and 3). At this period any appearance of erythrophilous bodies outside the nucleus is extremely rare. A few hair-cells may have undergone division; but, as a rule, they continue to be unicellular throughout life. Dumb-bell shaped nuclei (Fig. 3) are very common, both at this period and later. I examined 50 cells of this stage, making careful drawings of each serial section, and found that there were as follows:—

Hairs with three to six nucleoli ...	14
Hairs with two nucleoli	24
Hairs with one nucleolus	12

Only two cells of the total number contained crystalloids or granules; and these occurred in the lower, better nourished, and therefore more mature part of the ovary. One of them had one nucleolus; and the other contained two.

On the examination of the ovary of a *bud about seven millemetres long*, numbers of erythrophilous granules and slender

crystalline rods are found in the cytoplasm. I believe the granules are also crystalline in form; but they are usually so very small that I have not satisfied myself on this point (Figs. 4 and 5, *cr.* and *crk.*).

Out of fifty cells of this stage examined and drawn, there were as follows:—

Hairs with more than two nucleoli	...	9
Hairs with two nucleoli ...	...	19
Hairs with a single nucleolus	...	22

Of the twenty-two cells containing one nucleolus, eighteen had erythrophilous granules and crystalloids outside the nucleus; two of the cells with two nucleoli showed them, while the cell with three nucleoli only exhibited a few granules.

In the *ovaries of opening flowers* the hairs are at their fullest state of development (Figs. 6 to 9), being often of very large size (Figs. 8 and 9). They stain intensely blue, owing to their exceeding richness in protoplasm; while the crystalloid bodies are conspicuous from their large size, and the brilliancy with which they take the red dye. The crystalloids now often resemble at first sight some of Zimmermann's figures of single large irregularly shaped ones, but with careful focussing they are seen to consist of conglomerations of smaller, generally elongated crystals (Figs. 8 and 9, *cr.*). Long, slender forms also occur singly, and show in transverse section an oblique rhomboidal outline. Occasionally they are bent or curved, and not infrequently one may observe them bordering a vacuole (Fig. 10). I examined and drew fifty hairs from the ovary of an opening flower, and of these there were:

Cells containing more than two nucleoli	..	1
Cells containing two nucleoli	...	7
Cells containing a single nucleolus	...	42

All these cells, except one containing two nucleoli, had granules and crystalloids in great profusion. The cell with three nucleoli has been represented in Fig. 8, and two of its nucleoli are seen to be very small.

In *fertilised ovaries*, when the ovule has undergone its first division, the few hairs which still retain their normal size and shape show some crystalloids; but the protoplasm and nuclei begin to exhibit the characeristtic affinity of degenerating cells for acid

dyes, for they stain of a purple colour (Figs. 11 and 13, *a*). Most of the hairs, however, are entirely red. Figs. 12 and 13, *b*, contain large vacuoles in the protoplasm (Fig. 12, *v*.), and also in the nucleus (*nv*.), and possess few or no crystalloids. Some of the hairs are quite withered and shrivelled up (Fig. 13, *b*). I have several times observed, lying in the loculi of ovaries of this age, groups of crystalloids discharged by withered hairs (Fig. 13, *c*). Sometimes the entire shrunken hair remains in close proximity to the crystalloids; at other times, as in Fig. 13, only a few traces of protoplasm, *pr*., are discernible about the group, looking as if a large hair had burst.

The gradual increase in quantity of the cytoplasmic, and corresponding diminution of nucleolar erythrophilous matter, would seem to point to some relation of the crystalloids to the nucleolus, which latter has been regarded by some authors as a storehouse of nourishment.

Stock has further shown that protein crystalloids are deposits of reserve albumen, and Green* has lately examined the style of the lily, and states that "The distribution of nutritive material, especially starch, in this organ was found to have a very definite relation to the progress of the pollen tube;" and further, "The nutrition of the tube is a process in which the grain itself, and the tissue through which it grows take a part, both contain a reserve material and enzymes."

May it, therefore, not be that the function of the placental hairs, so rich in protoplasm and crystalloids, is to nourish and thus to guide the pollen tube?

A parallel chain of facts to that furnished by the life-history of the hairs is given by those epidermal cells lining the three slits which are placed symmetrically in the tissue of the ovaries, and are formed by the upper surfaces of the three carpellary leaves failing to unite at these places. In young buds these cells show several nucleoli, frequently six. In older stages the nucleoli diminish in number to one, which latter is often so diminutive as to be all but imperceptible; at this time minute hexagonal crystalloids make their appearance in the cytoplasm (Fig. 14, *cr*.). Out

* Green, *Annals of Botany*, June, 1894.

of fifty such cells examined in the ovary of a bud of 5 millemetres in length there were :—

Nuclei with more than two nucleoli	...	19
Nuclei with two nucleoli ...	...	26
Nuclei with only one nucleolus	...	5

None of them showed erythrophilous bodies external to the nucleus. Out of fifty cells from the ovary of an opening flower there were :—

Nuclei with more than two nucleoli	...	0
Nuclei with two nucleoli ...	...	6
Nuclei with only one nucleolus	...	44

All these cells showed the little crystalloids.

Undoubtedly, in this case, the number of nucleoli in the individual cells is diminished to some extent by cell multiplication : and, if there is really any connection between the crystalloids and nucleoli, this may account for the small size of the crystalloids in these cells.

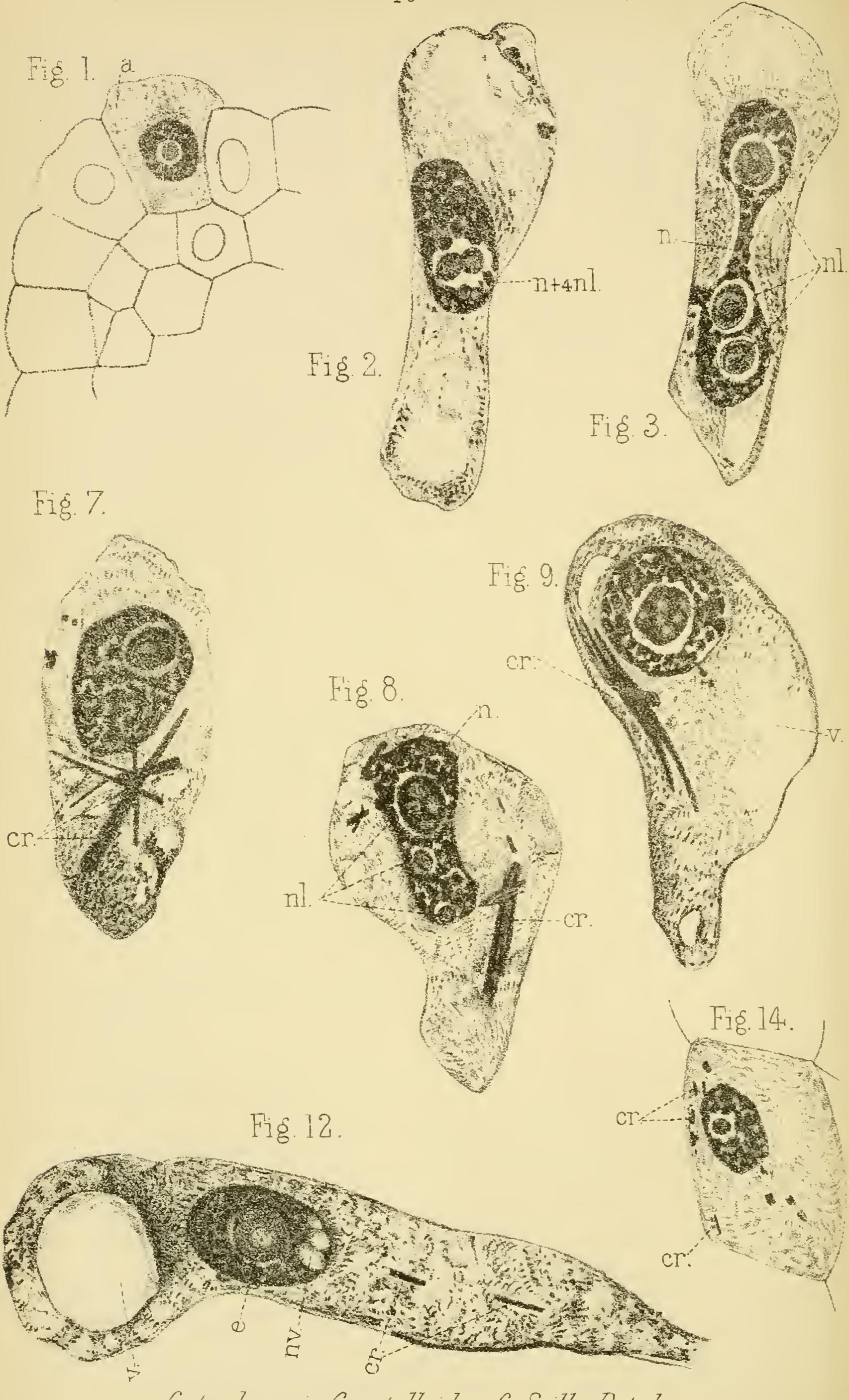
Belong long I hope to carry out some investigations on living material ; and also to extend the research to the ovaries of allied plants. The only one of these, which, owing to the time of year, I have been able to procure as yet—*Hyacinthus orientalis albulus*—was forced in a greenhouse, and shows in the hair-cells of a mature ovary, and in some other cells of the ovarian wall cubical crystalloids like those of the potato tuber, but I have not had the opportunity of investigating the history of these crystalloids as yet.

In conclusion, I gladly avail myself of this opportunity to acknowledge my deep obligation to Dr. Gustav Mann for his constant and invaluable help throughout the preparation of this paper.

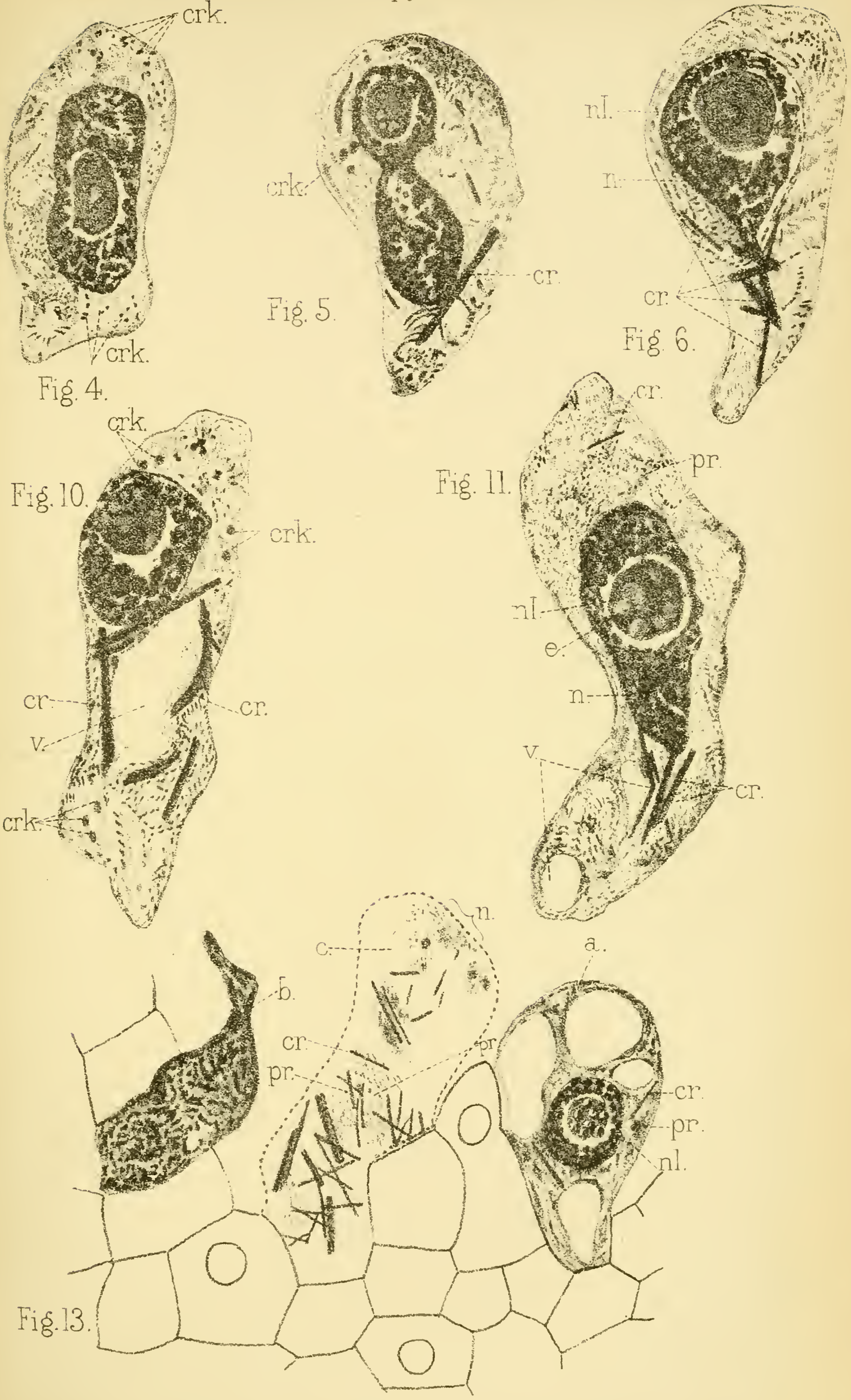
EXPLANATION OF PLATE V.

All the figures were drawn with the help of Zeiss's camera lucida, the paper being placed on the table and inclined at an angle of 20°. Except for Figs. 1 and 13, Leitz's 1/12th oil immersion objective was used with Zeiss's No. 4 ocular. For Figs. 1 and 13 Leitz's 1/12th oil immersion objective with Zeiss's ocular No. 2 was employed.

List of Abbreviations.—*a*, Cell showing senescence. *b*, Withered cell. *c*, Burst cell. *pr.*, Protoplasm. *n.*, Nucleus. *nl.*, Nucleolus. *e.*, Endonucleolus. *v.*, Vacuole. *n.v.*, Nuclear vacuole. *cr.*, Crystalloid. *crk.*, Granular crystalloids.



Cytoplasmic Crystalloids of Scilla Patula.



Cytoplasmic Crystalloids of Scilla Patula.

Fig. 1.—From young ovary, 3 millemetres in length. Hair cell, *a*, at the stage when it is first distinguishable from other epidermal cells.

,, 2—3.—Hairs from ovary, 5 millemetres long. No erythrophilous bodies outside the nucleus. Fig. 2 shows 4 nucleoli in the nucleus. Fig. 3 exhibits characteristic dumb-bell shaped nucleus, containing 3 nucleoli.

,, 4—5.—From an ovary 7 millemetres in length. Fig. 4 is a very typical hair-cell of this stage, with numerous small erythrophilous granules in the cytoplasm, *crk*. Fig. 5 shows slender crystalloids, *cr.*, as well as granules, *crk*.

,, 6—10.—Mature hair-cells from the ovary of an opening flower. Fig. 6, the nucleus has a peculiar, almost pear-shaped outline ; 9 small crystalloids are seen in the cytoplasm. Fig. 7 shows a group of large and small elongated crystalloids. Fig. 8 shows a nucleus with 1 large and 2 small nucleoli, one of which is close to the periphery of the nucleus. There is a conglomerate mass of crystalloids in the cytoplasm, and also a few small scattered rods and granules. Fig. 9, Hair-cell with one conglomerate group of large crystalloids, and exhibiting marked vacuolation of the cytoplasm, *v*. Fig. 10 shows a large vacuole, *v.*, surrounded by crystalloids.

,, 11—13.—From an ovary in which fertilisation had taken place, and the ova of which in most of the ovules had undergone their first division. Fig. 11.—Large hair-cell, in which the protoplasm and nucleus have commenced to degenerate; crystalloids are still present. Fig. 12.—Very long hair, with degenerated protoplasm. There is a very large vacuole in the cytoplasm, *v.*, and the nucleus is also vacuolated, *n.v.*, while the nucleolus has a large single, centrally placed endonucleolus, *e*. Two crystalloids lie in the cytoplasm. Fig. 13 shows a partially degenerated and much vacuolated hair-cell, *a* ; a completely withered hair, *b* ; and a group of crystalloids, *c* ; which have been discharged by a withered cell, the latter being represented only by vestiges of cytoplasm, *pr.*, and nucleus, *n*.

,, 14.—Cell from dorsal epidermis of carpellary leaf, containing small rhomboidal crystalloids.

On the New Gases—Argon and Helium.

By G. F. Hardcastle,
Assistant in the Chemical Dept. Hudd. Tech. College.

ARGON.

DURING the last three or four years, Lord Rayleigh, the well-known physicist, has been engaged in the determination of the densities of various gases. The method he used was the one used by Regnault, viz., weighing the gas contained in a large glass globe. Nitrogen was one of the gases whose density he determined. He obtained his nitrogen in the first case by bubbling air through liquid ammonia, and then passing it through a red hot tube. The excess of ammonia was absorbed by acid, and the water by ordinary dessicating agents. He then weighed the nitrogen obtained from air by absorbing the oxygen with red-hot copper. The nitrogen by this latter method was found to be one-thousandth part heavier than that by the former method. He afterwards performed several experiments with nitrogen derived wholly from ammonia and other chemical compounds. This nitrogen he called "chemical" nitrogen, in distinction to "atmospheric" nitrogen, or that derived from air. The results of these experiments showed that atmospheric nitrogen was about ·5 per cent. heavier than chemical nitrogen. The following figures represent the actual weights in grams of the globe full of gas, which he obtained in these experiments:—

Atmospheric Nitrogen.		Chemical Nitrogen.	
By hot copper - - - -	2·3103	From nitric oxide - - -	2·3001
,, hot iron - - - - -	2·3100	,, nitrous oxide - - -	2·2990
,, ferrous hydrate - -	2·3102	,, ammonium nitrite -	2·2987

These results seemed to suggest that there is in atmospheric nitrogen some other constituent heavier than true nitrogen. Cavendish had also noticed in his experiments that, after sparking the nitrogen of the atmosphere with oxygen for a long time, there was a small residue amounting to about 1/120th of the original nitrogen. He did not examine the matter any further, but stated that if any other body was present than nitrogen, it was not there in greater quantity

than 1/120th of the nitrogen. At this point Lord Rayleigh was assisted in his investigations by Prof. Ramsay. They succeeded in isolating the heavier constituent of atmospheric nitrogen, to which they have given the name of "Argon." One of the methods used by them for this purpose was the same as that used by Cavendish. They used a very powerful induction coil and alternating dynamo currents. The air was mixed with oxygen, and sparked for several hours in contact with strong caustic alkali. The excess of oxygen was removed by ordinary methods. The other method which they used was to remove the oxygen from air with red-hot copper, and then absorb the nitrogen by red-hot magnesium.

Separation of Argon on a large scale.—To prepare argon on a large scale a quantity of air was first freed from oxygen by means of red-hot copper, and the atmospheric nitrogen remaining was stored in a gas-holder. The gas was passed from the gas-holder through sulphuric acid to indicate the rate of flow, and then dried over soda-lime and phosphorus pentoxide. It then passed through a combustion tube packed with magnesium turnings and heated to redness in a furnace. The current of gas and heat were carefully regulated so as not to soften the glass tube. The gas was then passed over a mixture of copper and copper oxide, again over soda-lime and phosphorus pentoxide, and then into a system of tubes containing red-hot magnesium turnings. It was kept circulating till no further absorption took place, and was then pumped out of the tubes and transferred to a mercury gas-holder. The removal of the last portions of nitrogen is very slow, but circulation for two days usually effects it, as far as can be shown by the spectrum. As this test will show the presence of 1½ per cent. of nitrogen it is certain that the argon so obtained did not contain more than 1½ per cent. of nitrogen. The oxygen method is the slower one of the two, but at the same time it requires less attention than the magnesium one. If an alternating current can be readily obtained, then the oxygen method would be the easier to work.

Properties.—That argon is a very inert gas is proved by the method used for its isolation. Nitrogen itself is generally considered inert, but it will combine under certain circumstances with oxygen and magnesium, whereas argon will not. Titanium at a red heat

has a great affinity for nitrogen, but argon does not combine with it. Berthelot states however that, under the influence of a silent electrical discharge, argon will combine with benzene vapour. Argon prepared by both the oxygen and magnesium methods has about the same solubility in water as oxygen, and is 2½ times as soluble as nitrogen. The fact that argon is more soluble in water than nitrogen would lead one to expect an increased proportion of it in the dissolved gases of rain-water, and this has been proved by experiment. The spectrum of argon has been examined carefully by Mr. Crookes, and is different to that of any known element. The light of the electrical discharge in argon is under some circumstances red, and under others blue. The density of argon has been determined, and found to be 19·9. The ratio of the specific heats of argon as determined by Prof. Ramsay is represented by the number 1·65, which is very close to the theoretical limit 1·66. Hence it follows that argon is monatomic. The presence of argon in the atmosphere has also been proved by atmolysis. The atmolyser used was made by combining a number of churchwarden tobacco pipes. These were enclosed in a glass tube so arranged that the outsides of the tobacco pipes could be kept in a partial vacuum. Air was drawn slowly through by means of a bottle aspirator filled with water, and so regulated that only two per cent. of the air entering the pipes reached the outlet. The residual gas, after the removal of oxygen and water, was found to be considerably heavier than atmospheric nitrogen.

Argon is not present in the nitrogen derived from chemical sources. To show this fifteen litres of nitrogen prepared from ammonium nitrite were treated in exactly the same manner as the atmospheric nitrogen by the oxygen method. The residue amounted to 3·5 c c., whereas if atmospheric nitrogen had been used it would have been 150 c.c. But if chemical nitrogen contains no argon how is it that there were 3·5 c.c. of argon left? The source of this is to be sought for in the large quantities of water used in the manipulation of the large amount of gas under treatment. Argon is somewhat soluble in water, and, during the process, no doubt some of it will be evolved.

Argon has been liquified and even solidified by Prof. Olszewski. The sample of gas which he experimented with was very pure, and

had been prepared by the magnesium process. It showed no trace of nitrogen when examined in a vacuum tube. It boils at — 186·9°C, and melts at — 189·6°C. Its critical temperature is — 121°C, and critical pressure 50·6 (?) atmospheres.

Then we come to the question, What is argon? Is it an element, mixture, or compound? The ratio of the sp. heats shows that it is a monatomic element, or a mixture of monatomic elements. Again, the fact that it possesses both a definite boiling-point and melting-point would seem to indicate that it is not a mixture. On the other hand, argon has two spectra which can be separated to some extent in a vacuum tube (Crookes), and this appears to show that argon is a mixture. This fact is not quite so definite as the other two. If argon is a monatomic element its atomic weight will be about 40.

HELIUM—A Constituent of certain Minerals.

Soon after the discovery of argon, Prof. Ramsay, while trying to find some substance which would combine with that gas, came across a paper by Hillebrand. In this paper it was stated that on boiling uraninite with dilute sulphuric acid a gas was given off which proved to be nitrogen. On trying the experiment he found that only ten per cent. of the gas was nitrogen, and the rest was a new gas. His further experiments were carried on with the same gas obtained from cleveite. On examining by means of the spectroscope he found that the gas consisted of argon along with a totally new gas. In the spectrum of this new gas was seen a bright yellow line, coinciding with the line D_3 in the solar chromosphere, and attributed to the hypothetical element termed helium in 1868 by Profs. Lockyer and Frankland. The investigation of this has been carried on by Prof. Ramsay, assisted by Dr. Collie and Mr. Travers.

Terrestrial Sources of Helium.—The method of obtaining the gas from these minerals was as follows:—The mineral (two to five grms.) was coarsely powdered and heated in a hard glass bulb, which had previously been exhausted. Any water and carbon dioxide were absorbed by soda-lime and phosphorus pentoxide. Then the gas was sparked with oxygen to remove hydrogen, and the excess of oxygen was absorbed by alkaline pyrogallate. For spectroscopical analysis the gas was transferred to a vacuum tube by means

of a Topler's pump. They also examined the gases obtained from many other minerals by means of the spectroscope, and their spectra are identical with the spectrum of helium from cleveite. From a careful examination of these minerals it seems that the helium is retained by those consisting of salts of uranium, yttrium, and thorium. The three principal minerals which are available as sources of helium are cleveite, uraninite, and bröggerite.

Properties.—In many cases sufficient helium could not be obtained in order to ascertain its density. Sufficient gas, however, has been obtained from cleveite and bröggerite to enable the density to be determined. The maximum density of the original gas from cleveite was 3·89. This sample contained a little nitrogen. In these determinations of the density of helium the utmost care was taken to get the gas pure from nitrogen, carbon dioxide, sulphur dioxide, sulphuretted hydrogen, and hydrogen. The density of the gas got from bröggerite by fusion with potassium bisulphate was taken, and also of the gas from cleveite. The following figures were obtained :—

Gas from bröggerite by heating	2·152	
„ „ „ „ potassium bisulphate	2·187	oxygen = 16
„ „ cleveite	2·205	
Mean.	2·181	

The wave length of sound in helium was measured, and from this the ratio of the sp. heats was calculated. This was found to be 1·652, which comes near the theoretical number 1·66. This gas had a density of 2·133. Hence helium is monatomic. It is not attacked by oxygen under the electric discharge, nor is it oxidised by red-hot copper oxide. Red-hot magnesium does not affect it. It is sparingly soluble in water. At 18°C 1 vol. water dissolves ·0073 vol. helium. It is altogether insoluble in alcohol and benzene. In the spectrum of helium there are two lines in the red which are coincident with two of the argon lines. A close analogy exists between argon and helium. Both are monatomic, if we draw the usual inference from the ratio between their sp. heats. If we assume that this inference is correct, then it follows that their atomic weights are identical with their molecular weights. The

molecular weight is twice the density; hence for helium the molecular weight and also the atomic weight is $2 \cdot 13 \times 2 = 4 \cdot 26$. This is again on the assumption that helium is an element and not a mixture. If the atomic weight of argon is 40, then there is no place for it in the periodic system. It has not yet been proved that it is not a mixture. From the spectra it seems that each gas has a common ingredient. The density of helium does not leave much room for the presence of a large quantity of a heavier constituent. To fit the periodic system the density of argon should be diminished by the removal of a heavier constituent, rather than increased by the removal of a lighter one. Again, assuming that the other constituent of argon, if there be one, is a heavier one, and that helium contains the same, then, even if it be present in a very small quantity, it will reduce the density of helium considerably, and consequently bring it much nearer to that of hydrogen.

Remarkable Eye-Structure in a Fish.

MR. W. Tegetmeier has recently called attention to a fish, which is very curious as regards the organisation of its eyes, of which, like its congeners, it has two, although it well merits the name (*tetraophthalmus*) that attributes four to it. This fish has extremely bulging eyes, and when it is swimming upon the surface, as is its custom, half of the eye is above the surface of the water and the other half beneath it. Even externally, something abnormal is observed in these eyes. In fact, from the conjunctiva there starts a horizontal band of a dark colour that divides the eye into two parts—an upper and a lower. But the division is more profound still. There is a sort of halving of the pupil so as to form two—an upper and a lower—to which correspond a common iris that tends to a division, in the sense that a fold of this membrane separates the upper iris from the lower. But all this would not permit the animal to see in the air as well as in the water, were there not added a special arrangement of the crystalline lens. The crystalline of terrestrial animals has the form of a lens, but, in order to see in water, it requires a nearly

spherical one. The Anableps possesses both such forms. Mr. Stewart, who has carefully dissected the optical organ of this curious fish, shows that the crystalline lens itself is likewise halved, the upper part being lenticular, while the lower part, beneath the conjunctival band, is nearly spherical. There is, therefore, in this case a very marked adaptation, the upper part of the eye being adapted for vision in the air, and the lower part being conformable to the type required for vision in water. It is very probable that the structure of the upper half is acquired, although it would be difficult to prove the fact. Perhaps such adaptation might be made to disappear by causing the fish to live entirely under water. —*Scientific American.*

Intelligence in Ants.

THE January number of *Revista Brasileira*, a monthly magazine recently started in Rio Janeiro, contains an interesting note upon the intelligence displayed by the so-called Sauba Ant (probably *Œcodoma cepalotes).* It seems to be the general opinion that these ants spare the coffee-trees that grow about the ant-hills. They enjoy the shade afforded by these evergreen trees, whose roots penetrate their galleries, and hence endeavour to preserve them, despoiling only those which furnish them no protection. The writer of the note referred to witnessed near Rio an interesting exhibition of the intelligence of these insects. A "Rosinante," lodged in a stable built of boards, was being daily defrauded of a portion of his rations by the saubas. We quote, says *Insect Life*, from a translation from the Portuguese, kindly sent us by Mr. J. C. Branner :—

"No sooner was the corn put in the feed-trough than the scouting ants announced the fact, and a line of workers was immediately established, and, penetrating by the cracks between the boards, they came out, each one loaded with a grain of corn, with which it descended on the outside. In this descent there was a reëntrant angle, difficult to cross ; a single worker stationed itself there and undertook to help the others over. It did this by

taking part of the weight of the grain of corn, and backing across ahead of its companion until it had got it to a safe place. After helping one it returned to meet another, and continued this apparently voluntary task as long as this systematic robbery lasted."—*Scientific American.*

The Origin and History of Varieties of Agate, Flint, and other Siliceous Nodules.

By C. D. Hardcastle, Leeds.

AGATES have been defined as siliceous concretions or concretionary nodules, formed in cavities in the trap and kindred rocks. They can scarcely be said, however, to be concretions in the ordinarily accepted meaning of that term.

A concretion—from the Latin *con* and *cresco*, to grow together—is an aggregation of mineral matter of a different kind from the matrix in which it is embedded, formed round a central point or line, attracted generally by some organic matter, as a sponge, fern, leaf, or shell, which frequently remains enclosed, but is sometimes nearly, if not altogether, obliterated. These may be illustrated by sponge in flint, Echinus in flint, etc., fern and leaf in Dudley ironstone, Ammonite in lias, and *Productus* in coal measure sandstone.

Agates—as a general rule, at all events—are formed by infiltration of silica into cavities in rocks by consecutive layers, laid on the walls of the cavities in the first instance, and continuing towards the centre, which is filled up last; or, perhaps, in some cases, the cavity is filled up almost at once with colloid silica, much in the way that a mould is filled with metal in casting. There is no organism enclosed, as in concretions On this account it has been proposed to call agates secretionary or incretionary nodules.

Concretions of various kinds are formed in all classes of sedimentary strata from the alluvial sands and clays of recent date, to the deposits of palœozoic age. Nodules of carbonate of lime occur in recent and tertiary clays—jaspers in the sandy clay deposits of the Nile, and menelite in other tertiary deposits. The

best known are the flints of the chalk, chert of the green-sand and limestone, and the clay ironstone nodules of the coal measures. The Egyptian jaspers of the Nile Valley and some flints from the chalk are frequently called Agates on account of the concentric and other peculiar markings which they exhibit.

Agates are hard, siliceous nodules of fine texture, transparent to translucent, formed by the infiltration of siliceous waters into cavities in various kinds of volcanic and igneous rocks; and consist, to a large extent, of successive alternate concentric layers of various kinds of chalcedony, jasper, and opal; and quartz in the form of rock crystal and amethyst, and these sometimes are covered with chalcedony when the cavity has only been partially filled, as is the case in many geodes (hollow nodules). Specimens may be seen with an outer circle of amethyst and amethyst crystals on one side of the cavity, and quartz crystals lined with chalcedony on the other. Many geodes are lined with amethyst or quartz crystals only. When fresh supplies of siliceous waters have been continued, the central cavity has been filled by the quartz crystals on each side, meeting in the centre.

Agates receive different names in accordance with the arrangements of bands, stripes, spots, and clouds of various colours, as red, green, blue, yellow, white, brown, and black, with which they are inwardly variegated. Those which have stripes or bands of various colours arranged in straight parallel lines are called ribbon agates on account of their resemblance to ribbon. The term, fortification agate, is applied when the parallel bands assume a zigzag angular arrangement, somewhat in the form of a fort.

Eye Agate consists of a number of concentric rings of various colours surrounding a dark central spot, and somewhat resembles a human eye; sometimes the circles appear to be sufficiently round to have been drawn by a compass. I have a fair specimen, with a reddish-brown iris, surrounded by four alternate circles of bluish white, and black or very dark brown chalcedony, surrounded by a band of crystalline quartz.

Moss Agate is a translucent chalcedony, which appears to include embedded moss, ferns, seaweed, small vegetable filaments, and other arborescent forms. It is sometimes called tree agate, and some of the varieties are called Mocha-stone, either from

having been formerly supplied by traders from Mocha in Arabia, or as a corrupted form of the Latin *muscus* through the Italian *moschos*—moss. Eminent mineralogists have differed in opinion as to whether the markings were due to embedded vegetation or to mineral infiltrations. The latter opinion now prevails, analysis failing to detect vegetable substances, while various mineral matters are traced in the minute cracks and porous portions of the stone, giving the appearance of ferns, foliage, and moss.

Onyx is banded agate containing bands of two or more different colours. If one of the bands be red-carnelian or sard, the stone is called a sardonyx.

Brecciated Agate.—Some of these stones are very beautiful, and have the various constituents—Amethyst quartz, chalcedony, and jasper—being blended so as to produce contrast and harmony in a pleasing manner. Specimens of these may be seen in Ruskins' collections at the Sheffield Museum. It is thought by some authorities that the original agate has been, perhaps, by some earth movement, faulted, broken into fragments, and re-cemented by infiltration of silica.

The main constituent of agate is chalcedony, and some agates are composed entirely of it; but generally one or more of the other constituents occur with it. Some agates consist of chalcedony only; others of chalcedony and jasper; others, again, of chalcedony and quartz, chalcedony quartz and jasper, and chalcedony, amethyst, and jasper. In order to understand the composition and formation of an agate, a clear definition of these various forms is almost indispensable, although difficult to give.

Chalcedony may be defined as a crypto-crystalline form of silica. According to Fuch and Dana, it is "Hydrated quartz, or quartz with opal disseminated through it," and generally containing a certain proportion of alumina. Bauerman says it "is essentially a mixture of quartz and amorphous silica, forming botryoidal, reniform, or stalactitic masses, generally greyish or yellowish, white, blue, rarely brown or red, and from translucent to nearly opaque." It does not occur in definite crystals. It is readily distinguished when it appears in a stalactitic form, but its principal characteristic is its reniform structure, not only being kidney-shaped, but showing under the microscope numerous incipient

acicular or needle-shaped crystals, radiating from a centre, and giving to polished specimens a beautiful mammillated or mottled appearance. Chalcedony has a waxy lustre, is semi-transparent to translucent, and of various colours. The tendency to a reniform structure is supposed to play an important part in forming the circular and curved lines in agates. These are also affected by the stalactitic process.

Quartz in agates is pure silica, crystalline, as in vein quartz, and crystallised, as in rock crystal, generally occupying the centre of the cavity, but occasionally the outer rim and intermediate zones. The strong tendency of quartz to crystallise in straight lines and form true hexagonal prisms interferes with the circular force exerted by chalcedony, and promotes the formation of irregular figures in agates.

Jasper is a compact, amorphous, or non-crystalline, opaque variety of quartz, having in some kinds a dull earthy, and in others a conchoidal, or partially conchoidal, fracture. The opacity is the result of alteration and the addition of oxides of iron and other impurities. Some heliotropes or jasper bloodstones, being chalcedonic varieties, are translucent at the edges. Many jaspers are altered or metamorphosed sandstones, and porcelain jasper is merely baked clay or shale, produced either by volcanic or plutonic action, or by the burning of beds of coal in close proximity. Ribbon jasper consists of parallel layers of various shades of red, green, white, and yellow colours.

Egyptian Jasper occurs in nodules in the mud of the Nile and in the sandy deposits in the district around Cairo. Central bands divide the nodules into zones of various shades of brown colour, the central zone being generally light brown, separated from other lightish-brown zones by darker bands. These zones are supposed to result from decomposition and subsequent colouring, in the same way as zones in clay-ironstone nodules are produced. Prof. Ruskin says jasper is eminently retractile, like the clay in septaria, and in agates often breaks into warped fragments, dragging the rest of the stone into distortions. In general, the embedded fragments in any brecciated agate will be mainly of jasper, the cement chalcedonic, or quartzose.

Opal—which is an occasional constituent of agate—is an

amorphous or non-crystalline form of hydrated silica, containing water in varying proportions of from 5 to 12 per cent. It is brittle and has a conchoidal fracture. Precious opal owes its distinction to a rich iridescent play of colours. Common and semi-opal are opaque or semi-translucent, white or yellowish brown, and are not used in jewelry. Fire opal is red and brilliant, with bright reflections.

Flint is a variety of silica allied to chalcedony, but distinguished from it by being more opaque and brittle, and by having a more perfect conchoidal fracture; also by being more capable of forming sharp cutting edges, and is so hard as to scratch quartz. Flint nodules are often found on the British coast, especially the south coast, and the Isle of Wight, beautifully banded. They are polished by lapidaries and sold as agates; but are easily distinguished from true agates. Some red flints are passed as jaspers and some as carnelians. Prof. Ruskin names flint as one of the constituents of agate, but the apparent flinty portions of agate are rather a variety of chalcedony than the flint of the chalk, though chalcedony sometimes occurs in chalk.

We will now consider the mode of formation of agates. It has been already stated that agates occupy cavities in varieties of amygdaloidal trap rocks. Several problems difficult of solution here present themselves:—

1.—How were the cavities produced?

2.—Whence the supply of silica of which the agates are composed?

3.—How the silica entered the cavities and became arranged in bands, etc.

4.—How was the colouring effected?

1.—*As to the origin of the cavities.*—The agate-bearing rocks were originally, for the most part, molten lavas emitted from ancient volcanoes. It is well known that volcanoes eject large quantities of steam and gas. When these occur at the same time as an eruption of lava, they fill it with steam or gas, as the case may be. These bubbles rise to the surface and burst when the lava is in an almost liquid condition. As it becomes more viscid, the vapours or gases have less power, and as the rock or lava consolidates they escape or evaporate, leaving cavities such as may be

seen in loaves of bread that have been over-risen. These cavities are subsequently filled with silica, sometimes in a crystallised, and at other times a crystalline, an amorphous, or a colloid condition, and resulting in the production of different mineral constituents. That the cavities were thus formed is proved by the fact that they are elongated generally in one direction—that is, in the direction of the flow, instead of being globular or pear-shaped, with the smaller end downwards, as indeed some are where the flow has not been rapid. Some Continental writers who have been reluctant to acknowledge the igneous origin of basalt and trap-rocks have contended that the cavities have been pre-occupied by crystals of calc-spar and other minerals, which on decomposition have left vacuities which have afterwards been occupied by the agates.

2.—*The Source of the Silica.*—One theory is that after the rocks were consolidated, siliceous waters, supplied from deep-seated sources, as in the case of geysers and other hot springs, permeated them and gradually deposited silica in the cavities.

According to another theory, water containing carbonic acid dissolved the felspar from the rocks and deposited the silica thus set free in the cavities. And a third theory premises that also from the rock itself silica was derived by a process of sublimation produced by heat. Others have supposed that the mineral matter has been conveyed by water from superincumbent rocks, as is the case with the calc-spar in the Derbyshire Toadstone.

That the silica is derived from the strata which contains the agates is pretty certain, for the more decomposed the traps are, the richer, better, and more consolidated are the Agates.

3.—We must now consider the mode of entrance, deposition, and arrangement of the various forms of silica in the cavity. Some agates are cut so as to exhibit an apparent opening into the cavity at one end, and sometimes in one or two other places. An inspection of such a stone will show that the circumferential bands do not meet at the smaller end, but run out on each side, forming a bottle-neck kind of channel. Through this channel or orifice it has generally been supposed the silica- or agate-forming material entered and spread itself by some unexplained method around the sides of the cavities, in layers of different kinds and colours, as

successive supplies of silica arrived. This orifice has been called the point of infiltration. If the silica did enter in solution in this way, it is not easy to understand how it could arrange itself around the walls of the cavity, and on the roof as well as on the floor in layers of equal thickness. To overcome this difficulty, Dr. Lange, of Idar, has suggested that after gelatinous silica, or silica in solution, had been deposited on the floor of the cavity, an accession of temperature caused the water to boil, and that the pressure of the steam forced the jelly in all directions, and that when the tension became too great it pierced an exit. Hence he calls these apertures irruptive canals.

Another theory to account for the equal deposition of the layers is that, as the saturated solution entered by the aperture, a current would be produced between the solutions outside and inside to establish an equilibrium, and the current sometimes passed out at another aperture opposite, only partially coating the cavity, but frequently rising above and passing round the roof and out at the same opening by which it entered.

Dr. Rensch has tried to imitate the formation of an agate by introducing into an irregularly formed cavity a thin cream of plaster of Paris, shaking it round and pouring it out, when a layer is left lining the walls of the hollow. This he repeated with various coloured creams, forming successive layers until the cavity was filled. A section of the nodule cut through presented the appearance of a banded agate. He supposes that the cavities in the amygdaloidal rocks were alternately filled and emptied by the action of intermittent thermal springs.

In many agates a succession of varying bands continues to near the centre, which frequently is filled up with compact silica, chalcedony, or jasper; but very often the centre is occupied by quartz crystals. Sometimes the crystals meet and blend so as to form a compact crystalline or semi-crystallised centre; at other times the crystals from each side just touch, showing a division line between them. Sometimes they do not meet, but leave a hollow studded with pyramidal crystals of quartz, rock crystal, or amethyst; these hollow nodules are called geodes. The shell is, of course, a material of about a quarter of an inch thick, and covered inwardly with globular concretions. These, again, are

studded over with thousands of minute quartz crystals, and then on these several dog-tooth calc-spar crystals have been deposited.

The theory that the various layers have been deposited by silica in solution entering through an aperture has been objected to, and another has been proposed and strongly advocated by Dr. Haidenger in Germany and Prof. Heddle and others in England. Their theory is that the silica enters the cavity in solution by a general exudation through its walls in a colloid or gelatinous condition, the first supply leaving a thin coating all round on the sides and roof as well as on the floor; while the centre of the cavity is filled with water more or less pure. A fresh supply of a strong solution, and by a process of dialysis, passes through the first or any number of thin skins or layers, and as the layers increase forces out the water through the channel which has been supposed to be the point of entrance. An objection that some of the layers of agate are impermeable and would not admit of the passage of the silica through them, has been met by the fact that the microscope shows that the concentric circles are crossed by radiating crystals of tridamyte, through which the silica, and also various colouring matters pass towards the centre of the cavity. But perhaps the layers which now appear impermeable were not so originally.

Some agates are entirely filled up by concentric layers; others by concentric and horizontal layers; and others, again, have, in addition to these, a portion filled with compact chalcedony or with quartz crystals. The concentric layers were evidently first produced by a slow process; the horizontal layers may have been the result of a more rapid accession of silica, or, as some scientists think, by chemical precipitation on the floor of the cavity by the introduction of an acid, as CO_2, into the cavity. The remaining portion, by an influx of silica, being filled in the one case with chalcedony and in the other with quartz crystals formed by silica held in solution, crystallising in the unfilled portion of the cavity.

The deposition of the successive layers of silica has not always proceeded from the outside inwards; frequently, it appears to have proceeded from fixed centres by a radiating or stalactitic process. The action of acids on gelatinous or colloid silica appears to have the effect of producing slender tubes or pipettes of consolidated crystalline matter, and gradually depositing layer upon layer

outside the tube, until the cavity is filled or the growth stopped by the cessation of the supply of silica. Sometimes the original tube remains hollow, but generally it is filled up, leaving a dark spot in the centre, with circles surrounding, showing the marks of intermittent growth, as in the case of the eye agate and other circular forms.

It has been suggested that some of the forms of fortification, and other irregularly formed agates have been determined by crystals of calc-spar having been formed in the cavities, and afterwards dissolved, and their places filled up with colloid silica. But in many fortification agates, the lines appear to follow the outline of the cavity.

Professors Woodward, Ruskin, and others suppose the lines and markings of many agates procured from the drift are the result of decomposition since the agates were set free from their native matrix and embedded in the drift, as is known to be the case with many banded and variously coloured flints.

Locality and Geological Position.—The river Achate in Sicily (now called the Drillo) is said by Theophrastus about 300 B.C. (the earliest Greek writer on stones whose works are still extant) to have given its name to the agate. The agate, he says, is an elegant stone ; it has its name from the river Achate in Sicily, and is sold at a great price. Pliny, in the first century of the Christian era, informs us that the Achate was a stone formerly held in high estimation, but in his day was of little or no value ; that it was first found in Sicily, but has since been discovered in many other places, including Cyprus, Phrygia, Egypt, and India.

Prof. Forbes (in *Oriental Memoirs*) says the best agates are found in peculiar strata thirty feet under the surface of the earth in a small tract among the Rajpipla Hills, on the banks of the Nerbudda. They are not met with in any other part of Guzerat, and are generally cut and polished in Cambay.

Agates are now procured from various parts of the globe : Africa, North and South America (especially Brazil), Australia, Russia, China, India, Germany, and Scotland. They are found plentifully in the Amygdaloidal trap-rocks of Scotland, notably at Kinnoul hill in Perthshire, at Burne Anne near Galston in Ayrshire, near Montrose in Forfarshire, on the beach, in the sands, in

alluvium and boulder clay on the east and west coasts, both of Scotland and England. These, as well as the extensive supply now obtained from the gravels of the Uruguay and other rivers of Brazil, have all been washed out of trap-rocks of one kind or another.

The principal seat of the Agate industry in Europe is situated in the valley of the Nahe, a tributary of the Rhine, which it joins between the celebrated Mouse tower and Bingen. It is a fine valley, bounded especially in its upper reaches by hills which rise in ragged and grotesque crags, crowned with the relics of ancient baronial castles. The river rises in the mountains which bound the valley of the Moselle east of Treves and Saarbruck. The Hunsdruck hills, ranging on the left bank of the Nahe, are composed of Devonian Strata. The hills at the source of the river are of volcanic origin, and have burst through the coal-field of Saarbruck, and for some distance along the valley of the Nahe are surrounded by permian rocks.

The volcanic rocks of the Galgenberg hills consist of the kind of rock, called by Brougniart, melaphyre. "The uppermost bed," says Dr. Billing—to whom I am indebted for much information on this part of the subject—" is a flinty conglomerate, composed of water-worn gravel, of quartz, porphyritic or other trap stones, worn into pebbles, and united by ferruginous earthy matter, and much burnt by a stratum of trap-rock below it, which forced it out of its level to an inclination of nearly 40 degrees." Underlying this conglomerate is a dark brown amygdaloidal trap more or less porphyritic, and passing into greenstone ; and again below this lies another kind of trap rock, which constitutes the hill Galgenberg, near the town of Idar, which is the depository of chalcedony and agates, which has rendered the district celebrated. Below this is another stratum of trap, darker, denser, and more of the nature of basalt in the lower bed than in the higher, which contains the agates.

Agates formerly abounded in the alluvium at the foot of the Galgenberg, and were readily collected ; and from very early times workshops were established at Oberstein and Idar to grind, cut, and polish them, There is documentary evidence that they existed as early as 1454, and the industry was then an old one.

Early in the present century the supply of agates began to fail, and could only be obtained by mining, and that with great difficulty and expense. The mines are not now worked, as better agates can be obtained at a cheaper rate from South America and other places.

In 1827 two German agate-cutters, who had emigrated to South America, observed that a courtyard at St. Leopoldo, in the valley of the Uruguay, was paved with pebbles of agate, similar to those they had been accustomed to work at Oberstein. They collected a number of specimens from the drift in the bed of the river Taquarie, and sent them to Oberstein, when, after being cut, stained, and polished, they were pronounced to be of excellent quality, and well adapted for general use, the carnelians being especially good. Fresh supplies were sent for, and as they were plentiful, large quantities were collected and sent over in ships as ballast, at a trifling expense. This discovery gave a great impetus to the agate industry, and the demand for agates increasing, the landowners began to charge a royalty, the Governments of Brazil and Uruguay put a tax on the exports, and the shipowners charged for freightage. Consequently the cost of working was considerably increased, but still there is a good demand for the stones, and they constitute the principal source of supply for the agate industries of Europe.

Agates are collected in the valleys of the tributaries of the Uruguay, and sent down to various ports on the coast in waggons drawn by mules or oxen ; and are generally shipped to Hamburgh, Antwerp, or Havre, from Buenos-Ayres or Monte-Video ; and ultimately to Oberstein, where they are sorted and sold by auction in open market, or in the courtyard of one or other of the Inns. This industry is carried on chiefly in the villages of Oberstein, Idar, and Birkenfeld, and in numerous neighbouring hamlets in the valley of the Nahe, and its various small tributaries which supply the water to turn the numerous small mills at which the agates are ground, cut, and polished. The little river or brook Idarbach flows through Idar at the height of 1,012 feet above sea level and Oberstein, near which it joins the Nahe at 905 feet. The majority of the agate mills are situated in the valley between the two towns, which are about two miles distant from one another.

The red sandstone of the Zweibruken furnishes grindstones usually from five to six feet in diameter, with which the agates are ground down; the stronger and coarser agates are chipped into shape with the hammer, and then ground, the finer ones are cut with circular steel plates with plain discs, covered with oil and emery powder, and for finer work diamond dust; and polished on rotating wood or lead cylinders, moistened with tripoli. The labour of grinding is severe. "The workman," says Professor Rudler, "lies upon a low wooden grinding stool, specially constructed to fit to the chest and abdomen, leaving the limbs free. The hands are engaged in holding and guiding the agate, whilst the feet are firmly pressed against short stakes or blocks of wood screwed into the floor; the reaction enabling the grinder to press the agate with much force against the moving millstone. The millstones rotate at the rate of 180 revolutions per minute, and the friction is sufficient to rasp down the hardest stones. About 180 mills, with 850 grindstones, are kept constantly employed. A number of workmen are employed in cutting cameos and intagli in carnelian or sard and onyx.

The artificial colouring of stones forms a separate branch of the agate industry. The art of colouring stones artificially was known to the ancients and preserved by the Italian cameo lapidaries in Rome, but kept as a secret, and was unknown in Germany until about 1819, when a German lapidary and a Roman stone engraver were imprisoned in the same cell in Paris, and during conversation the Italian let out the secret, which was soon made known and practised in Oberstein, when common grey chalcedonies of no value were stained and transformed to good onyx, thus giving an impetus to the industry.

The porous bands of the agate may be stained almost any colour by artificial means, while the finer and harder bands, being impervious, are unaffected. One method is to wash the stones and dry them thoroughly, then steep them in oil and honey or some other saccharine substance and water, and after a few days expose them to a moderate heat; then after washing, to place them in sulphuric acid, and again expose them to a gentle heat. The oily and saccharine matter, being absorbed by the porous portions of the stone, is acted upon and decom-

posed by the sulphuric acid, and a deposit of carbon produced. Colourless banded agates are in this manner changed into onyx with black or dark brown and white layers. The bluish-white chalcedonies are changed in the process by heat to almost pure white; and perhaps the contrast of colour causes the white bands to appear whiter than they really are.

The sard or red tint is produced by soaking colourless or grey chalcedony in a solution consisting of nitric acid, water, and iron, and then heating it. Blue, green, and yellow tints are also produced by chemical means, the colour depending upon the salt in which it is boiled and the re-agent used to precipitate the colour required. Deep colours can be reduced by the action of nitric acid.

The principal colouring matters in agates, as found in nature, are various oxides of iron and manganese, and probably chrome. Polished stones, agate, onyx, sardonyx, etc., are made into ornamental articles of various kinds by German, French, Italian, and other lapidaries, as brooches, bracelets, beads, seals, snuff-boxes, small vases, paper-knives, handles for knives and forks, etc. The common agates are used in leather dressing, paint-pounding, etc., and for mortars for chemists to pound their drugs in.

In Eastern countries they are used for inlaying in marble pillars, cornices, and other portions of palatial buildings. Mr. Forbes, in his *Oriental Memoirs*, says:—"I was delighted with the mausoleums of Botwab, though they are inferior to those at Agra and Delhi, where imperial wealth and magnificence had united to decorate the tombs of the Mogul princes and their favourite sultanas, the ornamental parts being entirely composed of agates, carnelians, turquoises, lapis-lazuli, and other valuable gems."

On the restoration of Crathie Church—where the Queen and Royal Family occasionally attend during their residence at Balmoral—a polished granite pulpit was erected during the present year (1895), which is inlaid with agate pebbles collected on the shore in the island of Iona by Princess Louise, Marchioness of Lorne.

Agate Superstitions.

Camillous Leonardus, M.D., 1502, says:—"It subdues the poison of vipers, and scorpions if bound on the puncture, or

being bruised and drank in a glass of wine. Indian agate refreshes the sight by looking on it. Being held in the mouth, it quenches thirst. It gives victory to him that wears it; turns away storms, and puts a stop to lightnings.

Cretan agate renders the wearer of it gracious and eloquent. Preserves and confirms strength, and produces good colour or complexion."

Thomas Nichols, author of *The Lapidary, or The History of Precious Stones*, 1652, says:—"It is reported of the eagle that it doth carry this gemme (agate) into her nest to secure her young from the bitings of venomous creatures."

Robert Lowell, 1661, says:—"Agates of one colour causeth audacity. Being hung about the neck, it maketh prudent and eloquent, and preserves from danger."

FORMATION OF CHLOROPHYLL AND STARCH.—A very extended series of observations on the mode of formation of starch grains and chlorophyll bodies in plants has led M. E. Belzung to the following general conclusions:—The first process which takes place in the embryo is the formation of starch, the result of the activity of the protoplasm of the young embryo. The substratum of the future chlorophyll body—leucite or plastid—is always fully formed by the time the seed arrives at maturity; the protoplasm has always a reticulate structure; it is the protoplasm of the amyliferous vacuoles which constitute the chromatophore or leucite. Those starch-grains which are destined to constitute the reserve food material in the ripe seed are an exception to the rule, and increase as the embryo becomes green and the mass of green corpuscles more abundant, the starch grains are resorbed; they form a part of the material for building up the green chlorophyll grains. In adult green organs, especially leaves, the starch-grains, which are formed in the light in the chlorophyll bodies, are the result of the assimilating power of these latter, being one of the products of the substance itself of the chlorophyll bodies, a kind of secretion from the green substance. The resorption of the chlorophyll—which in leaves takes place only at the period of the autumnal fall—is, on fruits, effected almost entirely before they ripen. The two essential phases in the life of a plant—the embryonal phase, during which the green cell is built up at the expense of materials which it has not elaborated; and the adult phase, in which its formative activity is manifested by new embryonal conditions—constitute a remarkable example of organic reversibility.—Morot's *Journal de Botanique* in the *Pharm. Journ.*

British Hydrachnidæ.

By Chas. D. Soar. Part IV. Plate VI.

THE next genus we will consider is Nesæa. This is another large genus, and when worked out will number as many species as *Arrenurus*, if not more. Koch, in his *Deutschlands Crust.*, etc., describes and figures thirty-four species; some of these have since been removed to other genera. Koch himself, in his *Ubersicht*, reduced the number to twenty-eight, making a new genus for some, which he named Piona. We will notice this genus later on.

Several species of *Nesæa* are very common in England, some being very small, almost as small as *Axona versicolor*, others are as large as some species of *Hydrachna.* They also show a great diversity of colour, greens, browns, yellows, and reds of all shades, being represented by these little mites, one of the most beautiful being *Nesæa coccinea* (Koch). As they are soft skinned, I have not been able to mount any of them in Balsam successfully. The integument always collapses in mounting, and the slides are thus rendered useless. The best medium I have yet found in which to mount *Nesæa* is a 5 per cent. solution of formalin (this is a formula given me by Mr. Rousselet). It unfortunately removes the colour from the mite in the majority of cases (although not always), but it preserves the shape and structure beautifully; in fact, the ventral side is often more distinct when mounted in the medium than it is in life; of course, if a coloured drawing has been made from the life, it does not very much matter if the colour of the mite is removed. The mount will show all the structure, but as a beautiful object for the microscope it is spoilt.

Before we know very much about fresh water mites, the life history of some will have to be worked out. The metamorphosis from the egg to the imago will have to be carefully watched and studied. For this we want a naturalist with the time, perseverance, and ingenuity of Mr. Michael, who will do for the *Hydrachnidæ* what he has done so thoroughly for the British *Oribatidæ*; in two or three cases I know it has been done, as, *e.g.*, *Atax ypsilophora* by Van Beneden, in 1848; *Atax Bonzi* by Claparède, in 1868;

and *Arrenurus papillator*, and others, by Max Krendowski, the Russion Naturalist, in 1878. This will be found to be no easy matter, for I have no doubt the larva of *Nesæa* becomes parasitic at a very early stage. The query is, on what does it become parasitic? If the reader interested in this will turn to page 99 of *Science Gossip* for 1870, an outline drawing will be found called the Parasite of the Sand-fly, by W. Hanwell. If this drawing is compared with my outline drawing from the life of the larva of *Nesæa carnea*, Fig. 3, *g*, I think the conclusion arrived at will be that Mr. Hanwell's drawing represents also a larval form of an Hydrachnid.

We know by Krendowski's book that the larvæ of *Arrenurus papillator* spend some part of their time out of water, because he figures them on the wings of a Dragon-fly, These remarks will show some of the difficulties to be encountered. Accident or chance will, perhaps, reveal facts which have not been previously noticed; the great thing, I think, is first to become well acquainted with the larval forms, and then to search every living form, whether found in the water or out of it, that is likely to become a host for these little creatures. Of course, I am now referring to *Nesæa* only.

The *Oribatidæ*, which were so well worked out by Mr. Michael, are not parasitic at all at any part of their life. By finding out what the creatures fed on, keeping the cells moist, and the expenditure of a lot of patience and watchfulness, he was able successfully to trace their life-history from the egg to the perfect mite; but with the *Hydrachnidæ* it is different, I have traced several different species from the egg to the larva, and there I come to a full stop. My friend Dr. George, of Kirton-Lindsey, has also reached the same point with several mites, but like me has not, at present, succeeded in going further, except in the case of an undetermined species of *Hydrachna* which was found parasitic on *Dytiscus marginalis.*

The metamorphoses of *Nesæa* consist of four stages: first, the egg, but I am not quite certain that all water mites deposit eggs; some genera may prove to be ovoviviparous, but it is certain that the members of the genus *Nesæa* do deposit eggs; in confinement they lay them on the stalks and leaves of the water

plants, and on the sides of the glass tank, a batch of eggs at one time in a gelatinous film. Second we have the larval form, see Fig. 3, *g*, which is very unlike the adult, and is hexapod. Thirdly, we have the nymph. I have taken several of what I believe to be *Nesæa* in this stage; they have eight legs, but only two pores in a special plate, on each side of the genital fissure, but with my present limited knowledge I should not like to say to what species of *Nesæa* these different nymphs belonged. How long a time they exist in their various stages, and how many times they change their skin during these periods, are questions yet to be answered. Fourthy, the imago or perfect mite.

It will, perhaps, be interesting to give particulars of the development from the egg to the larval stage of *Nesæa carnea*, so far as my own observations have gone.

The Quekett Club during the summer months have an excursion every fourteen days to interesting collecting grounds round London, which is a great boon to members who live in London, and are engaged in business all the week. On May 18th, 1895, the excursion was to Staines. On Staines Common there are a number of small ponds, and from these ponds I took a number of water mites, which I believe to be *Nesæa carnea* (Koch). This mite is rather large, and of a deep maroon colour, long oval in shape, and the eyes stand out on two prominent swellings, which seems almost colourless compared to the rest of the body (I was not fortunate enough to take a male *N. carnea*).

On reaching home, I separated all the *Nesæa carnea* from other mites which I had collected, and put them into one small glass tank which stands on my window-sill, and next morning I found that a quantity of eggs had been laid on the water plants and the sides of the tank. I then took out three or four mites with a dipper, and put them into a small trough, and on the morning of the 20th I had the satisfaction of finding a batch of eggs laid in a most convenient position for microscopical examination. I again removed the mites and put the trough in position under the microscope, and examined the eggs at every opportunity. At first, they had the appearance of Fig. 3, orange red in colour, and embedded in a film of gelatinous matter, of a pale

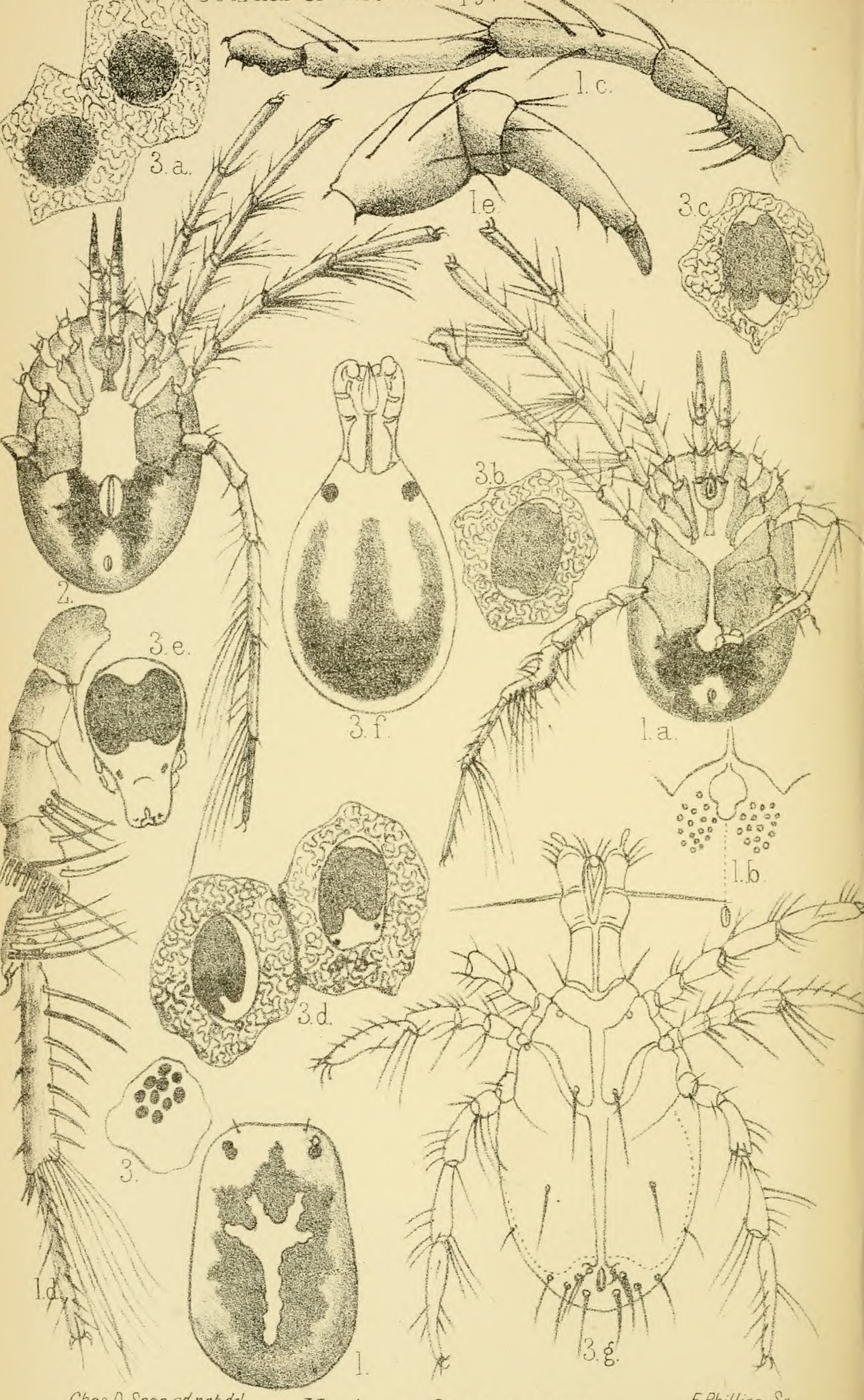
yellow colour. This film was covered—or at least appeared to be so—with little cracks; it was firmly attached to the glass. Fig. 3, *a*, shows the appearance of two eggs under a higher power. There were sixteen eggs in this one group. Each egg seemed to have its own share of film, although all were in one mass. The eggs gradually altered from circles to ovals, until on May the 24th they had the appearance of Fig. 3, *b*. It will here be noticed that the red portion of the little egg had begun to contract at each end. On May 28th they had the appearance of Fig. 3, *c*. On May 30th the eyes in some cases could be seen quite plainly (Fig. 3, *d*). On May 31st the shape of the little creature could be distinctly made out (Fig. 3, *e*); a constant movement of the limbs could be plainly seen. The delicate membrane in which the eggs were laid was also cracked all over in a very marked manner, no doubt for the purpose of letting the little creatures escape. On the morning of June the 1st, when I examined them, some three or four of the larvæ had escaped and were swimming freely about. When I looked again in the evening, all were out swimming vigorously.

Fig. 3, *g*, is drawn from the ventral side of one of the larvæ three days after it was hatched. How long they live in this form I cannot say. I placed all when hatched in a small tank with nothing but vegetable life, and found them alive on June the 20th. The larva is a pale yellow colour, with a bright red, double crescent-shaped patch on the body, as shown in Fig. 3, *f*, the shaded portions representing the red colour. This is as far as my own observations at present have gone with the larva of *Nesæa*.

Genus IV.—Nesæa (Koch).

1842.—C. L. Koch, *Übersicht des Arachnidensystems*, No. 3, p. 10.

Body, soft skinned; legs well supplied with swimming hairs; claws to all tarsi. The tarsi and ungues of the male, and the third and fourth pairs of legs specially modified. On each side of the sexual fissure are six or more so-called genital pores, either sunk into the skin or on special plates. The epimera form two separate groups on each side. Palpi not chelate; mandibles in two distinct portions; eyes wide apart.



Chas. D. Soar ad nat. del.

Nesaea Longicornis.

F. Phillips, Sc.

Nesæa Longicornis.

1834—41.—*Nesæa longicornis*, C. L. Koch, *Deutschlands Crust.*, etc., p. 9, Figs. 14 and 15.

Koch gives, in his *Ubersicht*, *Nesæa rosea* as his type of *Nesæa* (see Fab. I., Figs. 2 and 3). I have described and illustrated *Nesæa longicornis* because I happen to have a male and female of the same species. I have found several males of *Nesæa*, but am at present uncertain with which females to pair them off. Müller also figures *longicornis* on Twb. IV.. Fig. 4, and describes it on page 47. Newman also gives *N. longicornis*, but I am not certain if it can be the same as the one described by Koch. *N. longicornis* is pale yellow in colour, with dark brown patches on the dorsal side, and a red Y-shaped mark in the centre, extending from just behind the eyes to the posterior margin; in Koch's figure this mark is very plainly shown.

The first three joints of the legs, counting from the body, are pale yellow, which gradually turn to a pale blue on the last three joints, those of the male and female being the same in this respect. The body of the female is oval in shape. The legs are very much alike. The epimera (see Fig. 2) are wide apart. The body of the male is flattened on each side and bent inwards on the anterior margin. The epimera of the third and fourth pairs of legs are close together; they very nearly, but do not quite touch (see Fig. 1, *a*). Close to the posterior margin of the epimera is the genital fissure; the third pair of ungues of the males are more often than not firmly hooked into this part. I have endeavoured to show this on one side of Fig. 1, *a*. The fourth leg is very peculiar (see Fig. 1, *d*). The length of the body of the female is 13/150th of an inch, that of the male being 19/300th.

EXPLANATION OF PLATE VI.

Fig. 1.—Dorsal view of *Nesæa longicornis*, male.

,, 1, *a*.—Ventral view of same, showing on one side the way the third pair of feet are held in the genital opening.

,, 1, *b*.—Genital area of male.

,, 1, c.—Third leg of ,,

Fig. 1, *d.*—Fourth leg of male.
,, 1, *e.*—Palpus of ,,
,, 2.—Ventral view of *Nesœa longicornis*, female.
,, 3.—Eggs of *Nesœa carnea*, as deposited on side of glass.
,, 3*a*,
,, 3*b*,
,, 3*c*, Showing progress of development of the egg.
,, 3*d*,
,, 3*e*,
,, 3, *f.*—Dorsal side of larva at time of hatching.
,, 3, *g.*—Larva, ventral view, three days old.

THE BURNING TREE OF BURMAH.—There has lately been added to the collection of plants at the Botanic Garden, Madras, a tree bearing on the underside of its leaves stings which leave no outward sign when they pierce the skin, though the sensation of pain persists sometimes for months, and is especially keen on damp days or when the place which has been wounded is plunged into water. The natives in the parts of Burmah where the tree grows are said to be in such terror of it that they fly in haste when they perceive the peculiar odour which it exhales, and if they happen to touch the tree they fall on the ground and roll over and over on the earth, shrieking meanwhile. Dogs and horses touched by it run wildly about, biting and tearing the parts of their bodies that have been touched.—*Pharm. Journal.*

DISTRIBUTION OF SEEDS BY THE WIND.—Bolley (*Pop. Science News*) records some interesting facts on the distribution of seeds by the wind. In two square feet of a three-week-old and three-inch-deep snow-drift, on the ice of a pond ten yards from any weeds, he found nineteen weed seeds, and, in another drift, similarly situated, thirty-two seeds representing nine distinct species. While the wind was blowing twenty miles an hour, he poured out a peck of seeds upon the snow-crust, and ten minutes after one hundred and ninety-one wheat grains, fifty-six flax seeds, forty-three buck-wheat seeds, and ninety-one (American) rag-weed seeds were found in a trench thirty rods distant from where they had been poured out.—*Pharm. Journ.*

Limnæa Peregra.

By William Nelson.*

LIMNÆA PEREGRA—or, as it has been variously named, The wide-mouthed Helix, The Mud Snail, The Traveller, The Wanderer, The Wandering Mud Snail, etc.—is possessed of a rather long history. The first notice of it that I have seen is by Martin Lister, published in 1678. It has since then been described by a great number of writers, and has become possessed of a long string of names or synonyms, of which I have collected upwards of two hundred. These are in addition to the generic and sub-generic synonyms, and as the process is still going on there is no fixing the limits of its titles. The chief offenders in this respect are the French conchologists. The Germans are bad enough, though not nearly so culpable as the Bourguignat school. We ourselves are not without blame in this particular, as with some of our recognised authorities the chief requisite to command a new specific name seems only to be that it shall be found in a part of the world which has not previously been well explored; for it is no doubt much easier to sit down and describe under a new name than to laboriously overhaul what has already been written, and refer the form to its proper place in the genus to which it may belong. Another reason for the enormous mass of synonyms which has gathered round this species is, no doubt, the great variation in size, colour, shape, and texture, which again is accounted for by its excessively wide distribution and the great differences in its environment.

Passing over its ordinal and generic characters and coming to the species, the animal may be described as having the tentacles triangular, flat; the foot broad, obtusely rounded, and broader in front, and gradually narrowing, and somewhat pointed behind, and the underside of the foot grey.

The body varies greatly in colour and has been described by different observers as being dark-grey, brown, greenish brown, olive-yellow, or yellowish grey, often mottled with small ring-like

*Read before the Leeds Branch of the Conchological Society, Oct. 10, 1895.

markings of a lighter colour, which are readily seen through the shell in the thinner varieties.

The eyes are at the inner base of the tentacles.

In attempting to describe the shell we are confronted with a somewhat difficult task, the variations being so great that it is only by fixing upon a certain form as the type that this can be accomplished. We, therefore, take the elongated form as our idea of the type, and accept Dr. Jeffreys' description so far as it agrees with our own examination.

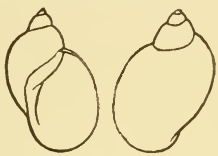


Fig. 1.—*L. peregra.*

Shell obliquely ovate, thin, moderately glossy, semi-transparent, yellowish-horn colour, irregularly striate by the lines of growth, epidermis thin, whorls four to five, convex, the last occupying three-fourths of the shell; spire produced and pointed, suture rather deep; mouth large, oval; outer lip thin (he says), slightly reflected (which scarcely agrees with my experience); inner lip folded on the columella, forming behind it a slight umbilical cleft; fold rather prominent and curved. Length three-quarters of an inch; breadth rather less than half-an-inch. Shell dextral. Dr. Jeffreys mentions some specimens from Ireland, which exceeded an inch and a quarter in length.

Reeve says there is no fear of mistaking the most widely inflated forms of *Limnæa peregra* for *L. auricularia*, but I am not quite sure of this, having personally known instances where this mistake has been made, even in the latest published work on the Mollusca.

Fig. 2.-var. *elongatissima.*

Limnæa auricularia has been figured as *L. peregra.* The long, narrow form—var. *elongatissima*—has also been mistaken for *Limnæa palustris*, and these mistakes made, too, by conchologists of ability. For a considerable time it has been customary to range *L. peregra* next to *L. involuta;* but of late opinion seems to be trending in the direction of suppressing the latter form as a species, and regarding it as a local variety of an extreme form of *L. peregra.* Even Dr. Gray, who was, as all will admit, a most

painstaking naturalist, refers the *Limneus acutus* of Jeffreys to *Limnæus peregra* var., whilst I think that most conchologists would agree with Dr. Jeffreys, and refer it, as he did later, to *L. auricularia.*

Von Maltzan unites *L. peregra* with *L. auricularia.* It certainly comes very near to *L. lagotis*, some of the numerous varieties of which can scarcely be separated from *L. peregra.*

Limnæa peregra has been found in a fossil state in the Mammalian Crag at Southwold and at Bramerton, also at Stutton and at Clacton. It is often found in a sub-fossil state, as at Askern, and in the banks of the Tutt at Staveley. Mr. Roebuck found fossil specimens in the mud cliffs at Hornsea, whilst myriads of this species are turned up by the drainers at Silverdale.

In a living state it occurs in rivers, streams, ditches, ponds, and lakes, at all elevations, from mountain tarns down to the brackish water on the sea beach, being found in ponds within reach of the spray from the sea-waves. A variety of it was collected by Dr. Hooker on the Thibetian Himalaya, at an elevation of 18,000 feet.

It is very generally distributed over the whole of the British Isles, throughout Europe, Afghanistan, Siberia, and throughout North America, under the name of *L. columella* and many other synonyms. It has also been found in Tasmania and described by Rev. E. Tenison Woods as *Limnæa hobartonensis*, *L. huonensis*, *L. launcestoniensis*, and lastly, a few years ago Dr. Edward Atkinson kindly presented me with a few freshwater shells, sent to him direct from a place called Tsing-fu-chu in North China, amongst which I was pleased to find our old acquaintance, *L. peregra.*

In some cases it is very difficult to account for the local distribution, seeing that it is almost invariably the first species to make its appearance in a new pond, as, for example, brick ponds, in situations where no flood water can reach, and near large towns, which are not likely to be visited by aquatic birds bringing a supply of young fry attached to their feet.

A few curious cases have been recorded of how they might become distributed. Mr. W. Thompson, in 1841, mentioned that he once saw a number of *L. peregra* attached to the backs of some turtles kept in a pond at Fort William near Belfast, and they

appear to have held on with some firmness, for the turtles were swimming about with the *Limnææ* still keeping their seat upon them. But still more curious is the case recorded by Mr. Standey, who states that in 1883 he saw a full-grown specimen of *L. peregra* upon the back of a toad, which was tramping leisurely along the road in the dusk of the evening in the vicinity of Goosnargh, near Preston, about twenty yards from the water of a roadside pond.

It is said to breed in August, but this, I think, must be a mistake, as my own experience has always been that they have deposited their spawn in March, April, and May. We are told that one individual deposits upwards of a thousand eggs. The eggs are round, colourless, or pellucid, with a whitish, opaque spot at one end. They generally number from forty to eighty or more in one mass, and are enclosed in narrow, cylindrical shaped masses of gelatinous or protoplasmic substance. The opaque spot becomes larger from day to day, and for several days before it leaves the mass it may be seen moving backwards and forwards.

Most of the full-grown animals which deposit their eggs in early summer at once die off, resembling in this particular many other of the lower order of animals, which seem to have attained their purpose when they have perpetuated their kind.

M. Bouchard-Chantereaux says that the eggs hatch in from fifteen to sixteen days, but no doubt in this, as in other species, the length of time will depend in a great measure upon the temperature. Mr. E. J. Lowe, in his excellent little work on *The Conchology of Nottingham*, says that it breeds in August; whilst the late Mr. Charles Ashford, with his usual accuracy, says: "Fry innumerable during May; no adults to be found after June." This I believe to be the experience of all outdoor naturalists. It is gregarious and rather active, being fond of floating on the surface of the water with the shell hanging down. It shares with its congener, *L. truncatula*, the habit of leaving the water and making peregrinations on the damp mud, sometimes to some distance from the water.

Although, as a rule, animals of this species are vegetable feeders, they have often been rightly charged with destroying fish in aquaria. There is also no doubt that they often eat the bodies

of their dead brethren. Clessin observes that it attacks the shells of its fellows only if vegetable food is wanting.

Mr. Jones states that he had frequently given *L. stagnalis* and *L. limosa* (another name for *L. peregra*) dead bleak and other small fish, which they have reduced to a skeleton in a very short time, although abundance of vegetable food was at hand. Dr. Gray says that in the spring these animals are often infested with a small, slender species of *Gordius*, which affix themselves to the edge of the mantle over the back of the neck. These parasitic worms are so common that Draparnaud mistook them for the respiratory organs of the animal. They are also preyed upon by leeches and fishes as well as aquatic birds. In fact, ducks are so particularly fond of molluscs, that where they are kept it is almost useless to search for shells.

Mr. J. W. Williams records having kept a number of *Dytisci* which he fed upon *L. stagnalis* and *L. peregra.* The beetles, though eating both species, evidently showed a preference for *L. stagnalis.*

Though a hardy species, *L. peregra* hibernates for a short time during winter, but for a rather longer period than *L. stagnalis.* The Rev. W. C. Hey records its behaviour under somewhat peculiar circumstances. The Ouse at York was considerably lowered by opening Naburn Lock, exposing a number of fresh-water shells on the muddy banks. The same night a keen frost set in, the mud becoming perfectly hard to the water's edge. The *L. peregra*, however, burrowed itself a hole in the mud, apparently by a rotatory movement of the shell, and lay there warm and damp. He says:—"I opened several of these holes, and do not think a single specimen died."

That it burrows in the mud to escape the cold I readily admit. At the same time, it does not seem to possess the knowledge how to escape the effects of heat as successfully as Mr. Hey credits it with regard to the frost, for we often find hundreds dead at the bottom of dried-up ponds in summer. But some allowance should be made here, for they may perhaps have deposited their ova and so completed their life purpose. But so long as there is sufficient moisture it can survive a very high temperature. In some of the mill-cisterns at Cheadle, Staffordshire, into which the

warm water is discharged, and which water during the day is constantly rising in temperature, the mollusc crawls out of the water when it reaches 120 degrees Fahrenheit. It has then stood as much of the heat as it is able. It, however, returns to the water again during the night, when the temperature is lower.

This species varies very much ; in fact, there is no particular in which there is not great variation. The shell may be very thin, as in var. *thermalis*, or very thick, as in var. *lutea* ; the spire may

Fig. 3.—var. *thermalis.*

Fig. 4.—var. *burnetti.*

Fig. 5.—var. *marginata.*

Fig. 6.—var. *labiosa.*

Fig. 7.—var. *obtusa.*

Fig. 8.—var. *oblonga.*

be produced, as in var. *elongatissima*, or even intorted, as in var. *burnetti;* it may be dark brown or pure white, the lip may be simple, as in the type, or it may be thickened, as in var. *marginata*, or reflected, as in var. *labiosa;* the front margin of the shell may be inflated and rounded, as in var. *obtusa*, or it may be compressed and flattened, as in var. *oblonga*. A good deal of ingenuity has been exercised by our ablest naturalists to account for the divergence between the long form, which is generally accepted as the type, and the globular or ovate forms, it being generally accepted that the long, narrow forms inhabit streams where less resistance is offered to the running water than would be the case by the globular forms ; hence the latter inhabit ponds where there is no motion in the water. Most of the Continental conchologists regard var. *ovata* as a distinct species ; but Hazay looks upon

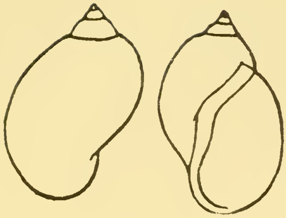


Fig. 9.—var. *ovata*.

L. peregra only as a biological variety of *Limnæa ovata*, produced by living in hard running water, and mentions cases in which eggs of *ovata* were transferred into springs or rivulets, and the animals hatched from them were *L. peregra*, and also *vice versa*. This, if correct, is, of course, very interesting. It certainly does not agree with my own out-of-door experience, some of the most elongated forms in my collection having been obtained from ponds.

Warm water produces thin shells, as var. *thermalis;* absence of lime a decollated shell; an interesting account of which, by Mr. Crowther, will be found in the *Naturalist* for 1879. Brackish water is said to be productive of stunted *L. peregra*, but of this I am very doubtful. There have as yet been no experiments made of which I have seen any record with *L. peregra* of such completeness and so full of interest as those made with *L. stagnalis* by Carl Semper, and until this has been done there will be many random guesses as to the cause of variation in this species.

For a long period three or four varieties were all that were recognised by British authors; then Dr. Jeffreys' work extended them to eleven, but since Darwin's work on the *Origin of Species* was written, the impetus given to specialisation has been so great that most small points which were then overlooked are now noted, so that a great many more named varieties will be required. But this extension should be made with great caution, otherwise the differences will be so slight that even the authors themselves will have no little difficulty in recognising their own work.

Then, last, we have to consider the abnormal shells, some of which are most strange in shape, some, no doubt, produced by injuries to the mantle, some sinistrally formed, some swollen out in part of their growth when food has no doubt been in abundance, then narrowing down again when harder times have come upon them; others are scalariform, perhaps caused by some obstruction to the shell-producing mantle continuing its work on the same plane of convolution. Many of the abnormal forms are

produced by transitory causes, the shells next season resuming their normal form. An interesting and instructive collection might be made from a single pond, continued over a series of years. This has been done, to a small extent, by our friend, Mr. Madison, and serves to show that slight alterations in the environment, so slight as to be imperceptible to the conchologist, still leave their impress upon the shells.

Mr. Purves describes and figures a specimen obtained by him on Belford Moor, Northumberland, which had a regular keel round the upper part of the whorl, giving the shell an appearance very unlike the normal form of the species. This was, no doubt, due to an injury to the mantle of the animal.

Dr. Brot mentions that in a pond in the environs of Geneva a number of abnormal forms of this species were obtained. The pond swarmed with *Hydra viridis*, which he fixed upon as the cause of the variation, being confirmed in this opinion by the disappearance simultaneously of the Hydra and the abnormally formed shells.

Fig. 10.-Abnormal Shell.

During March, 1883, I collected many specimens in a pond at Allerton Ings, the majority of them being deformed, the cause of which I ascribed at the time to superabundance of food.

The Germination of Oily Seeds.—According to M. Leclerc du Sablon, the reserve substance of oily seeds, whether they are stored up in the embryo or in the endosperm, consists chiefly of oil and aleurone; starch is but rarely found in them. In the species examined, the proportion of oil decreases regularly during the period of germination. By the action of a diastase, the oil is transformed into fatty acids without any separation of glycerin. During germination these fatty acids, instead of accumulating, are themselves transformed into carbo-hydrates, especially into those belonging to the group of saccharoses. This saccharose is again converted, by the action of a diastase, into glucose, which is directly assimilated by the plant. Starch is also temporarily present as an intermediate product between oil and glucose. Starch and oil, as reserve substances, give rise to the same assimilable products during the germination of the seed.—Bonnier's *Revue Générale de Botanique.*

Predacious & Parasitic Enemies of Aphides
(including a Study of Hyper-Parasites).

By H. C. A. Vine.

Part IV. Plates VII. and VIII.

THE Linnæan order, HEMIPTERA, to which the Aphides themselves belong, includes some species which are actively aphidivorous in all stages of their existence.

Like certain genera of the NEUROPTERA, this order is distinguished by the 'incomplete' character of the metamorphosis which the various species undergo, the adult differing from the larva form generally only in the possession of wings and in minor structural details, which are, however, of a nature to make the resemblance often difficult for an inexperienced eye to trace, especially in such genera as *Phyllaphis*, *Phylloxera*, *Calocoris*, and *Capsus.* The habits of the larva and the nature of its food are generally the same as that of the imago, and the acquisition of wings rarely involves any change in environment except such as is due to an alternation of hosts. These circumstances, together with the coriaceous nature of the anterior pair of wings, led Linnæus to unite these insects in a single order with the ORTHOPTERA.

The totally different structure of the mouth parts rendered some further division necessary, and Latreille at a later date effected the separation of the incongruous groups, the distinguishing character of the *Hemiptera* since his time being the prolongation of the mouth into a fleshy *rostrum*, or beak, supporting four setæ, which are considered to be the homologues of the mandibles and maxillæ in other insects. The possession of this suctorial apparatus has led some naturalists to adopt the designation of *Rhynchota*, or 'beaked insects,' for the group in preference to the older term, *Hemiptera.* Similarly to the *Neuroptera*, the *Hemiptera* have been sub-divided into two great sections on the basis of their characteristic wing-structure. The best-known of these sub-orders (the *Hemiptera-Homoptera*) includes the Aphides, Cicadas, Thrips, Coccidæ, and other less-known groups, and its

distinguishing character is the possession by the imagines of four membranous wings.

The remainder of the order, designated *Hemiptera–Heteroptera*, bears in its name a reference to the partially coriaceous nature of the anterior wings, which, whilst serving, as in the *Coleoptera*, as a cover for the membranous pair beneath, are each furnished with an asymetrical membranous extension, which enables them to be used as effective instruments of flight. The species of this sub-order are popularly known as 'bugs,' and whether or no the unsavoury association of ideas thus engendered has had its effect upon the studies of naturalists, certain it is that the group, as a whole, has had but little attention devoted to it in comparison with the *Diptera*, or even with the other section of the same order. Probably, the 'water boatman,' the *Ranatra linearis*, the house bug, and a few others which, on account of peculiarities in their structure or habits, have found places in most manuals of microscopy, are almost the only species with which a vast number of naturalists are well acquainted, and we are yet greatly deficient in reliable information as to the development, the diagnosis of the larva, and the conditions under which the species live in the different stages of their existence.

The species of the *Hemiptera* differ greatly in shape and also in colour, bright green, black, red, brown, yellow, grey, etc., being all prevalent, and the generic characters, especially in the *Capsidæ*, require much patience and care in examination to ensure the correct placing of a specimen.

The great majority of the *Hemiptera* are vegetable feeders, inserting their rostra much after the manner of their victims, the aphides, into the softer structures of plants, and sucking up the juices through the delicate tubular setæ, to be presently described. It has, however, long been known that some species are carnivorous, though curiously enough this character has been entirely denied to the *Capsidæ* by most naturalists. Even Mr. Saunders, in his lately published work, says :—"All species occur in summer and early autumn, and subsist on the juices of leaves, etc."

Some few species are said to associate with ants, Mr. Douglas having found them in the nest of *Formica rubra*, and these may

thus come under the notice of the student of the *Aphididæ*, which affect a similar habit.

In walking round a country garden on a summer or autumn morning, one is almost sure to see on some of the dewy leaves a bright little fly of an elegant and narrowed form, almost emerald-green in colour, the iridescence of whose wing points, and the delicacy of whose slender antennæ render it an object of beauty. It is probably a member of the genus *Miris*, and although not itself an aphis-eater will serve to convey to an unfamiliar reader the nature of the insects now under review.

The *Hemiptera Heteroptera* are most conveniently considered under the sectional denominations of *Geocores*, or 'land bugs,' and *Hydrocores*, or 'water bugs.' The former, with which alone we are concerned, are distinguished from the latter by the presence of prominent antennæ, organs which in the water bugs are minute and usually concealed in the hollows of the faces of the insect.

The numerous families will be presently detailed, but so far as I am aware two only can be at present certainly shown to be aphis-eaters—namely, the *Anthocoridæ* and the *Capsidæ*. Mr. McLachlan mentions in the *Ent. Proc.*, 1879—80, that the *Lygeidæ* are also aphis-eaters, and it is not impossible, as the family is known to include some insectivorous species; but I have not myself been able to obtain any definite evidence on the point.

The *Anthocoridæ* are among the most common of the species, and may usually be found in summer on any hedgerow. Saunders, in his monograph of the *Heteroptera*, describes them generally as aphis-eaters; but I cannot satisfy myself that the habit extends to any species except *A. sylvestris* (Lin.) and probably *A. memoralis* (Fabr.), which appears to have been occasionally confused with the former species, under the specific designation, *nemorum*.

The *Capsidæ* are usually considered to be vegetable feeders, and are so described by Kirby (*Entomology*, 203), and the opinion appears to have been generally accepted. Mr. McLachlan, however, in the paper above referred to, mentions the family as aphidivorous, and I have myself repeatedly met with *Capsus lanarius* in its larva and nymph stages sucking the juices of aphides. Mr. C. J. Watkins has related to me some similar instances, and Mr.

J. W. Douglas, in the *Ento. Monthly Mag.* for Oct., 1895, gives so exact a description of the attack that I venture to transcribe it :—

"*Capsus lanarius* feeding.—This species, like all other *Capsidæ*, is credited with being a feeder on the juices of leaves, and I was therefore somewhat surprised yesterday to see one individual that was not a vegetarian. On the flower umbels of a *Heracleum*, the stems of which were literally covered by the larvæ of a pale-green aphid, the *Capsus* stood motionless, rostrum exerted and arched, the tip in the body of one of the aphids, and so gently inserted (after the manner in which Isaac Walton advises a hook to be passed into a worm), that there was no resistance by the victim. If this was the beginning of a feast, there was an abundant supply of the delicacy to continue the revel, which in the nature of things could not last long." Mr. Douglas also gives some later observations of the same fact, and it may be considered to be established beyond question that this particular Capsid at least enjoys a carnivorous diet.

In the spring of 1895 I was fortunate enough to secure a specimen of *C. lanarius* (larva) attacking an aphis, and after watching it turn suddenly over the edge of the leaf and insert its rostrum into the victim I removed the fragment of leaf, and mounted it at once in a deep cell with the two insects still *in situ*, and the beak of the capsid plunged deeply into the abdomen of the pear aphis before it. The insects, as taken, are shown in the central figure of Plate VIII.

Before proceeding to examine these insects in detail, it will be desirable to show their position in systematic classification instead of, as in previous groups, leaving this until the last section. My object in so doing is to enable readers who have not made a special study of the order to realise the relations of the species which will be investigated.

The following synopsis of the Insecta, with especial reference to those groups which are nearest to the *Homoptera–Heteroptera*, will be useful in this direction :—

- *Class INSECTA.*
  - Sub-class, Mandibulata.
    - COLEOPTERA, including Strepsiptera
    - ORTHOPTERA, including Thyanura.
    - NEUROPTERA, including Trichoptera, Thysanoptera, etc.
    - HYMENOPTERA.
    - MALLOPHAGA.
  - Sub-class, Haustellata Labiata.
    - LEPIDOPTERA.
    - DIPTERA.
  - Sub-class, Haustellata Rostrata.
    - HEMIPTERA.
      - Sub-order, Homoptera
        - Cicadidæ
        - Cercopidæ.
        - Psyllidæ.
        - Aphididæ.
        - Coccidæ.
      - Sub-order, Heteroptera
        - Pentatomidæ
        - Coreidæ
        - Berytidæ
        - Lygeidæ.
        - Reduviidæ.
        - Saldidæ.
        - Tingididæ.
        - Aradidæ.
        - Cimicidæ.
        - Capsidæ.
        - Hebridæ.
        - Hydrometridæ.
        - Naucoridæ.
        - Nepidæ.
        - Notonectidæ
        - Corixidæ.
    - APHANIPTERA.
    - ANOPLURA.

Kirby, in his *Entomology*, has defined the *Hemiptera* as "haustellate insects, wings four, membranous, naked. The fore-wings (in the *Heteroptera*) of a parchment-like consistency (except sometimes at the tips), or (in the *Homoptera*) similar to the hind wings; metamorphosis incomplete; and in one group (*Aphides*) exhibiting alternation of generations." The *Hemiptera–Homoptera* he defines as follows:—"Fore-wings horny; hind wings and usually the tips of the fore-wings membranous; antennæ usually long, 4 or 5 jointed; head generally free."

This division includes the true Bugs, an extensive group of very varied structure and habits. The greater part of the terrestrial species feed on plants. A few, however, are carnivorous, feeding on other insects or sucking the blood of animals and birds, and most of the aquatic species are likewise carnivorous. Kirby divides the sub-order into 15 families:—

1.—Scutellaridæ.	9.—Emesidæ.
2.—Coreidæ.	10.—Saldidæ.
3.—*Lygeidæ.*	11.—Hydrometridæ.
4.—Phyrrocoridæ.	12.—Gerridæ.
5.—*Capsidæ.*	13.—Galgulidæ.
6.—Tingididæ.	14.—Mepidæ.
7.—*Cimicidæ.*	15.—Notanectidæ.
8.—Reduviidæ.	

The three families containing aphis-eating genera I have italicised, and on the authority of Mr. McLachlan have included the Lygeidæ.

Mr. Saunders, in his exhaustive Monograph of the *Heteroptera*, gives the following tabular statement of characters and families, which will assist in tracing the position of any species which may be found preying on Aphides :—

Table of Families.

1.—Antennæ free, not hidden	Gymnocerata.
2.—Abdomen, not clothed beneath with a silvery pubescence, species not aquatic.	
3.—Scutellum, reaching at least to the base of the membrane	*Pentatomidæ.*
4.—Scutellum not reaching to the base of the membrane (except in Aradidæ) ...	
5.—Mesopluræ and metapleuræ, composed of one piece only, elytra without a cuneus.	
6.—Tarsi, 3-jointed.	
7.—Rostrum, not bent at base, lying in repose against the under surface of the head...	
8.—Antennæ inserted above a line drawn from the centre of the eye to the apex of the face	
9.—Legs not very long, and slender femora not clavate at the apex	*Coreidæ.*
10.—Legs very long and slender, femora clavate at the apex	*Berytidæ.*
11.—Antennæ inserted below a line drawn from centre of eye to apex of face ...	*Lygeidæ.*

12.—Rostrum stout, bent at the base so that it does not lie against the under surface of the head in repose ... ...

13.—Rostrum long, ocelli placed between the eyes ... ... *Saldidæ.*

14.—Rostrum short, ocelli placed behind the eyes ... ... *Reduviidæ.*

15.—Tarsi, two-jointed.

16.—Anterior legs, inserted on the posterior margin of the prosternum ... .. *Tingididæ.*

17.—Anterior legs, inserted in the disc of the prosternum ... ... *Aradidæ.*

18.—Mesopluræ and metapluræ, composed of several pieces, elytra with a cuneus ...

19.—Elytra with an embolium ... ... *Cimicidæ.*

20.—Elytra without an embolium ... ... *Capsidæ.*

21.—Abdomen clothed beneath with a silvery, velvety pubescence; species aquatic or sub-aquatic ... ...

22.—Antennæ, five-jointed ... ... *Hebridæ.*

23.—Antennæ, four-jointed ... ... *Hydrometridæ.*

24.—Antennæ hidden in foveæ under the head CRYPTOCERATA.

25.—Anterior legs inserted on the disc or anterior margin of the prosternum ...

26.—Antennæ, with four simple joints, no anal appendix ... ... *Naucoridæ.*

27.—Antennæ with three joints, abdomen with a long anal tubular appendix ... *Nepidæ.*

28.—Anterior legs inserted on the posterior margin of the prosternum ... ...

29.—Rostrum, free, three- to four-jointed ... *Notonectidæ.*

30.—Rostrum, hidden, apparently unjointed... *Corixidæ.*

This arrangement of families corresponds very nearly with that of Kirby, and may be accepted as having the support of all naturalists who have devoted attention to the species of *Heteroptera* found in this country. The two families of *Cimicidæ* and *Capsidæ*, which are the only ones, the aphis-eating proclivities of

some of whose species has been demonstrated beyond doubt, have been divided by the same patient and illustrious naturalist under the following heads :—

Anthocarina (one of the four sub-families of the *Cimicidæ*).

	Genera.
1.—Third and fourth joints of the antennæ very fine and thin, clothed with long, erect hairs	
2.—Anterior femora, hardly thicker than the intermediate pair	*Lyctocoris.*
3.—Anterior femora incrassated, much thicker than the intermediate pair	*Piezostethus.*
4.—Third and fourth joints of the antennæ, scarcely or not thinner than the preceding, hairs not long and erect ...	
5.—Cell of the wing, with a hook-like nerve...	
6.—Pronotum, with a distinct apical collar ...	
7.—Apex of the metasternum between the coxæ, widely truncate	
8.—Rostrum, reaching to the intermediate coxæ	*Temnostethus.*
9.—Rostrum, not reaching beyond the centre of the mesothorax	*Elatophilus.*
10.—Apex of melasternum, rounded and narrower	
11.—Rostrum short, hardly reaching beyond the anterior coxæ	
12.—Apical collar of pronotum long, sides gradually diverging from it ...	*Anthocoris.*
13.—Apical collar short, sides widely rounded behind it	*Tetraphleps.*
14.—Rostrum reaching to the intermediate coxæ	*Acompocoris.*
15.—Pronotum without a distinct collar ..	*Triphleps.*
16.—Cell of the wing, without a hook-like nerve	
17.—Species robust, pubescent	
18.—Head short, scarcely longer than its width between the eyes	*Brachysteles.*

19.—Head much longer than its width between the eyes ... ... *Cardiastethus.*
20.—Species elongate, glabrous, parallel-sided. *Xylocoris.*

The only one of these genera which is definitely shown to comprise aphis-eating species is *Anthocoris*, but it seems probable that continued observation may reveal the same habit in others, particularly in *Tetraphleps* (Fieb.) and perhaps *Acompocoris* (Reut.). The genus *Piezostethus* (Fieb.) contains one species, *L. formicetorum* (Boh.), which appears to find a suitable home in the nests of *Formica rubra.* Hence, it may be found under these conditions in company with aphides possessing the same habit.

The details of the genus *Anthocoris* will be given later on.

The family *Capsidæ*—which, although very often stated to contain vegetable feeders only, includes, as has been mentioned, several genera of more or less carnivorous proclivities, whilst the species of two genera can be demonstrated to consume aphides as ordinary food. It is a numerous family, exhibiting a great variety of structure, of environment, and habit; but the patient observation of the student is not unlikely to be rewarded by the addition of some of its genera to the list of Aphis-eaters, in addition to those of *Capsus* and *Plagiognathus.*

The following tabular account of the genera of the *Capsidæ* is taken from Mr. Saunders' exhaustive work :—

1.—Head channelled in the centre or transversely impressed on the vertex; anterior margin of pronotum not callosely raised ... ...
2.—First joint of the posterior tarsi much longer than the second ... ...
3.—Head channelled down the middle ...
4.—Base of pronotum truncate, covering the base of the punctured scutellum ... *Miris* (Fab.).
5.—Base of pronotum emarginate, not covering the base of the impunctate scutellum ... ... *Megalocerœa* (Fieb.)
6.—Head transversely impressed on vertex..
7.—Eyes not, or scarcely, projecting beyond the lateral margin of the pronotum ... *Acetropis* (Fieb.).

8.—Eyes prominent, projecting considerably beyond the lateral margins of the pronotum ... ...

9.—Elongate, depressed, glabrous above, or nearly so ... ... *Teratocoris* (Fieb.).

10.—Elongate, not depressed, clothed with erect hairs ... ... *Leptopterna* (Fieb.).

11.—First and second joints of posterior tarsi, sub-equal ... ... *Pantilus* (Curtis).

12.—Head not channelled nor transversely impressed ... ...

13.—Pronotum, with the anterior margin raised and rounded, or constricted into a short collar-like neck, or much constricted in front and widened behind, with the sides sinuate, and the posterior margin largely emarginate ...

14.—Pronotum, with the lateral margins acute in front, anterior margin not callose...

15.—Eyes very prominent, species parallel sided, black and yellow, or red ... *Lopus* (Hahn).

16.—Eyes not very prominent, species oblong ovate, ochreous with brown stripes ... *Miridius* (Fieb.).

17.—Pronotum with the lateral margins not acute in front, or with the anterior margin callose ... .

18.—Pronotum gradually raised and rounded from the narrow anterior collar to the base, its sides rounded or straight, rarely sinuate, base not largely emarginate ... ...

19.—Membrane with two cells ... ...

20.—Large or medium-sized species; neck more or less swollen, head not divided from it even at the sides by a carina or raised line ... .

21.—Rostrum produced beyond the posterior coxæ ... ...

22.—Membrane marbled ... ... *Phytocoris* (Fall.).
23.—Membrane not marbled ... ... *Oncognathus* (Fieb.).
24.—Rostrum not produced beyond the posterior coxæ ... ...
25.—Species not deeply punctured nor rugose
26.—Second joint of antennæ not clavate ... *Calocoris* (Fieb.).
27.—Second joint of antennæ strongly clavate *Rhopaltomus* (Fieb.).
28.—Species deeply punctured or rugose ...
29.—Surface glabrous, both sexes macropterous *Capsus* (Fab.).
30.—Surface hairy, female generally brachyopterous ... ... *Bothynotus* (Fieb.).
31.—Medium-sized or small species; vertex of head completely or only in part (near each eye) divided from the neck by a transverse carina or rounded margin...
32.—Vertex carinated, at least near the eyes.
33.—Hemelytra and nervures of membrane, scarlet ... ... *Dichrooscytus* (Fieb.).
34.—Hemelytra not scarlet ... ...
35.—Pronotum scarcely convex, transversely rugose, elytra glabrous ... ... *Plesiocoris* (Fieb.).
36.—Pronotum convex, not transversely rugose, hemelytra more or less pubescent ...
37.—Species not clothed with scattered, deciduous, golden pubescence ...
38.—Head very wide, rostrum reaching beyond the posterior coxæ ... ... *Zygimus* (Fieb.).
39.—Head not very wide, rostrum reaching to about the posterior coxæ ... *Lygus* (Hahn).
40.—Species clothed with deciduous golden pubescence ... ... *Pœciloscytus* (Fieb.).
41.—Vertex not carinated, but with a rounded margin posteriorly, visible especially near the eyes, elytra glabrous ...
42.—Second joint of the antennæ shorter than the third and fourth together ... *Liocoris* (Fieb.).
43.—Second joint of antennæ longer than the third and fourth together *Camptobrochis* (Fieb.).

44.—Membrane with only one cell.
45.—Third and fourth joints of antennæ subequal ... ... *Bryocoris* (Fall.).
46.—Third joint distinctly longer than fourth *Monalocoris* (Dahlb.).
47.—Pronotum constricted in front, raised and widened posteriorly, sides generally sinuate, base largely emarginate ...
48.—Basal joint of posterior tarsi nearly three times as long as the second ... *Pithanus* (Fieb.).
49.—Basal joint of posterior tarsi not much longer than the second ... ...
50.—Eyes touching or nearly touching the anterior margin of the pronotum ...
51.—Third and fourth joints of the antennæ not, or scarcely, thinner than the apex of the second ... ...
52.—Antennæ somewhat robust, head with a slight vertical impression in the centre posteriorly ... ... *Allodapus* (Fieb.).
53.—Antennæ slender, vertex not impressed.
54.—Head between the eyes flat, lower than the eyes ... ... *Ætorhinus* (Fieb.).
55.—Head between the eyes, convex, higher than the eyes ... ... *Campyloneura* (Fieb.),
56.—Third and fourth joints of the antennæ, much thinner than the apex of the second.
57.—Second joint of the antennæ as long, or nearly as long, as the third and fourth together ... ...
58.—Callosities of pronotum scarcely prominent, elytra in both sexes fully developed ... ... *Cyllocoris* (Hahn).
59.—Callosities of pronotum very prominent, elytra in female generally not fully developed ... ... *Globiceps* (Latr.).
60.—Second joint of antennæ, much shorter than the third and fourth together ...

61.—Face nearly perpendicular—*i.e.*, nearly at right angles to the vertex, wing-cells without a hook-like nerve ... *Mecomma* (Fieb.) and *Cyrtorrhinus* (Fieb.).

62.—Face declivous, not nearly at right angles to the vertex, wing-cells with a hook-like nerve ... ... *Byrsoptera* (Spin.).

63.—Eyes not nearly touching the anterior margin of the pronotum ... ...

64.—Head constricted behind eyes; eyes large ... ...

65.—Posterior femora grooved ... ... *Systellonotus* (Fieb.).

66.—Posterior femora, not grooved ... *Dicyphus* (Fieb.).

67.—Head not constricted behind eyes; eyes small ... ... *Macrolophus* (Fieb.).

68.—Pronotum with anterior margin not raised and rounded, nor constricted into a short, collar-like neck, nor much constricted in front and widened behind in the same species, where the sides are sinuate and the base widely emarginate ...

69.—Eyes not nearly touching the anterior margin of the pronotum ... *Malacocoris* (Fieb.).

70.—Eyes quite or nearly touching the pronotum ... ...

71.—Head posteriorly very thin and flat, covering the apex of the pronotum; posterior tibiæ somewhat flattened and curved ... ... *Pilophorus* (Hahn).

72.—Posterior tibiæ, not curved and flattened

73.—Wing-cell without a hook-like nerve ...

74.—Head posteriorly more or less covering the front of the pronotum ...

75.—Antennæ nearly twice as long as the body *Halticus* (Hahn).

76.—Antennæ short, not so short as the body *Strongylocoris* (Cost.)

77.—Head not covering the pronotum in front

78.—Species black, clothed with scattered golden or silvery deciduous, scale-like pubescence ... ...

79.—Tibiæ with spine like hairs .. *Orthocephalus* (Fieb.)
80.—Tibiæ without spine-like hairs ..*Heterocordylus* (Fieb.).
81.—Species not clothed with golden or silvery deciduous, scale-like pubescence.
82.—Second joint of antennæ much dilated and flattened .. .. *Heterotoma* (Latr.).
83.—Second joint of antennæ not dilated and flattened ... ...
84.—Second joint of antennæ very long, one-half longer than the third and fourth together ... ... *Loxops* (Fieb.).
85.—Second joint of antennæ, not or scarcely longer than the third & fourth together
86.—Third and fourth joints of the rostrum, together longer than the second, not incrassated ... ... *Orthotylus* (Fieb.).
87.—Third and fourth joints of the rostrum, together not longer than the second, each slightly thickened towards their juncture ... ... *Hypsitylus* (Fieb.).
88.—Wing cell with a hook-like nerve (wanting in some specimens of *Asciodema obsoletum)* ... ...
89.—Elytra opaque, dull, or at most only very slightly shining, never clothed with pale, deciduous, scale-like pubescence.
90.—Tibiæ spotted with black ... ... *Oncotylus* (Fieb.).
91.—Tibiæ not spotted with black ..
92.—Claws exceedingly short, strongly curved, with an acute tooth at the base ... *Macrotylus* (Fieb.).
93.—Claws not very short and not strongly curved, without an acute basal tooth
94.—Arolia longer than the claws ...*Onychumenus* (Reut.).
95.—Arolia shorter than the claws ...
96.—Rostrum very long, extending beyond the posterior coxæ ... ... *Amblytylus* (Fieb.).
97.—Rostrum not very long, not extending to the posterior coxæ ... ...

98.—Upper surface with fine, pale, regular pubescence, spines sub-elongate ... *Conostethus* (Fieb.).

99.—Upper surface clothed with brown or black hairs, mixed with paler spines; sub-robust ... ...

100.—Antennæ with the third and fourth joints very little thinner than the second ... *Hoplomachus* (Fieb.).

101.—Antennæ with third and fourth joints much thinner than the second ... *Macrocoleus* (Fieb.).

102.—Elytra shining, often clothed with pale, deciduous, scale-like pubescence ...

103.—Second joint of antennæ shorter than the third ... ... *Harpocera* (Curtis).

104.—Second joint of the antennæ longer than the third ... ...

105.—Tibiæ with pale spines ... ...

106.—Elongate, depressed, elytra parallel-sided *Phylus* (Hahn).

107.—Not elongate and depressed, elytra with sides rounded ... .. *Plesiodema* (Reut.).

108.—Tibiæ with black spines ... ...

109.—Elytra clothed with short, deciduous, scale-like pubescence ... ...

110.—Second joint of antennæ in both sexes, incrassated ... . *Atractotomus* (Fieb.).

111.—Second joint of antennæ, not incrassated *Psallus* (Fieb.).

112.—Elytra clothed with fine regular hairs...

113.—Femora entirely pale ... ... *Asciodema* (Reut.).

114.—Femora more or less dark, or spotted with black or brown ... *Plagiognathus* (Fieb.).

The genus *Capsus* (Fab.) contains but two species found in Britain, and in all probability both are aphidivorous, although up to the present I have only observed, or been able to find, record of the first. The genus consists of strongly characterised species, dark-coloured black, red, and reddish brown in colour. The eyes project greatly, and the second joint of the antennæ is considerably thickened towards its extremity; the two last joints are not more than half the diameter of the second, often less, and together do not exceed it in length—generally are shorter. The elytra,

pronotum, and scutellum are strongly punctured, and the spines of the tibiæ are very small.

The two British genera are as follows :—

Capsus lanarius (Linn.). Robust, oval, black, reddish black or brown, shining. Femora black to pale in varying proportions ; tibiæ pale to brown ; coxæ large, brown to yellowish. Antennæ black, with portions of second joint and two final joints pale, all clothed with fine hairs. Anterior aspect of pronotum in proportion to base in about 1 to 3 or 1 to 4 ; angles of base rounded, black or stone-coloured yellow ; scutellum black or similar yellow, very prominent ; both pronotum and scutellum thickly punctured. Elytra black to brown or yellow, with a bright red patch on cuneus. Portions of corium often dull red, all variably punctured ; cuneus with a few stiff bristles, apex black usually ; membrane dark, with curved vein partly red. The lighter specimens seem to be generally females, and are furnished with an ovipositor dividing the posterior segments of the abdomen beneath. Mr. Saunders mentions that all his dark examples are males. The species is widely distributed, and may be found in gardens and on nettles, etc. The length of the larva is about 0·2 to 0·22, the nymph about 0·22 to 0·25 in., and the mature insect measures about 0·25 to 0·3 in. in length, and 0·5 to 0·6 in. across the expanded wings.

Capsus scutellaris (Fab.), black, somewhat longer than *C. lanarius*, bright shining, with narrow red line on head and scutellum (generally). Pronotum thickly and deeply punctured ; scutellum smooth, prominent, shining, and unpunctured ; elytra much as in *C. lanarius*, except for the patch on cuneus, and more closely punctured ; membrane dark, not spotted. I have not seen the larval form of this species, which is rare. The nymph measures some 0·25 to 0·266 in. in length, and the imago 0·3 to 0·35 in. These measurements are made on the male insect. The female is said to be slightly less. Widely distributed, but rare. Mr. Saunders has taken it on heather. I have found it on garden plants in the country.

The Anatomy of Aphidivorous Hemiptera.

The anatomy of the Capsidæ and of the Hemiptera generally presents some striking departures from the general structure of the

other orders, and minute as many of these insects are the details of their organisation are as much calculated to fill the observer with surprise as those of the more bulky Blow-Fly, which Lowne has described with such wonderful minuteness, or the Cockchafer, the organs of which are modelled in wax by Auzoux, and have attracted the learned and the curious on both sides of the Atlantic.

The despised 'bug,' however, is not less worthy of the skill of the dissector and microscopist, and presents so many features of interest in its larval and nymphal stages, that a fully detailed account would probably exceed the bulk of Lowne's classical work, and would certainly try the patience of the ordinary reader.

The characters of the Capsidæ are well marked, the structure of the antennæ, the absence of ocelli, and the details of the hemelytra serving to readily distinguish them. I have shown upon Pl. VII., at Figs. 1, 2, and 3, the larva, nymph, and imago of *Capsus lanarius*, and at Figs. 4 and 5 the coriaceous hemelytra and the membranous posterior wings. On Plate VIII. the details of the head and of the rostrum and some other parts are presented to the reader.

The Larva.

I have not been fortunate enough, in spite of much searching, to secure any specimen of the larva in its earliest stages of existence. At a few days old it is somewhat linear in aspect (as compared with the later forms). The abdomen, though flask-shaped, is flattened laterally, and the obtuse prominences apparent on either side of each segment, and in parallel lines upon the dorsal surface of the abdomen, stand much more revealed than in the stouter abdomen of the nymph, though, as in the latter, they are each tufted with a group of very curious flattened bristles, each one divided at its extremity into two or three points. These bristles are shown on Plate VIII., at Fig. 13, and from their flatness and the peculiar nature of their attachment to the epidermis are the most obvious and striking feature of the species. They do not appear to answer the purposes of ordinary hairs or bristles, for unlike these their attachment to the skin is slight, and although the solid-looking, chitinous ring or cup on the epidermis, which forms their base, would seem to indicate an important organ, yet

slight pressure or friction suffices to detach these curious appurtenances. I have been inclined to imagine that they were hollow tubes, which, originally cylindrical, as appears from the form of the base, had collapsed, from the delicacy of the membrane of which they were found; but an extended observation scarcely supports this view. Bristles of a similar form and structure are sparsely scattered on the general surface of the abdomen, thorax, and head, and one or two are generally found on the femora and a few on the first joints of the antennæ. Hairs and bristles of ordinary tapering form are intermixed, the proportion increasing on the femora and thicker joints of antennæ, whilst finer hairs are alone found on the tibiæ and terminal antennal joints.

The head in the larva has a much more pointed form than in the nymph or imago, the apex being formed by the base of the rostrum and the rather long-pointed labrum, which is folded down closely upon it. The antennæ exhibit but little difference in the size of the joints, the characteristic development of the two first belonging more especially to the nymphal stage. The quasi-caudal appendage, on the other hand, is remarkably prominent in the larva, and has the form of a short, truncated cone, which is often marked with longitudinal stripes on either side.

The Nymph.

The second (or *possibly* the *third)* casting of the larval skin reveals the wing-pads which indicate the nymph, and at this stage the abdomen assumes its fuller flask-shaped form, and the thorax becomes wider and shaped in a more suitable way for the support of the wings. The first and especially the second joints of the antennæ are more bulky, and the latter exhibits a marked increase of size towards its anterior extremity. The rostrum, however, is but little different from that of the larva. The details of this organ are shown on Plate VIII., Figs. 2 and 3, representing the upper and under side of the head, with the organ folded down upon the ventral surface of the thorax, as when at rest. The protuberance of the labrum and the numerous flattened bristles are noticeable features. In Fig. 4 the rostrum is shown, with the piercing organ raised from the sheath, formed between the lobes of the fleshy *labium*, for to this organ in the diptera the fleshy

portion of the rostrum corresponds. In Figs. 5, 6, 7, 8, and 9, the rostrum is shown in detail. It consists, as to its main structure, of two elongated fleshy lobes in four segments, which are closely united on the underside (assuming the rostrum to be extended); but on the upper surface form a deep groove, within which are the delicate setæ which constitute the piercing organ. The rostrum takes its rise in, or rather is a prolongation of, the front portion of the head, which is hollowed out on the underside so as to receive the organ when in repose, and folded back beneath the thorax.

When the rostrum is extended, the cavity thus formed is covered by a membrane, no doubt of a muscular nature, which at such times becomes tense and rigid, and which is continuous with the skin of the rostrum. The extremities of the labial lobes, as shown at Fig. 9, are two small, cushion-like organs, bearing each several stiff hairs, and which are all that represent the extensive labial terminations of the Diptera. Within the groove terminated by these cushions lie the four setæ constituting the alimentary apparatus. They consist of fine chitinous blades, the two central ones being nearly flat, parallel-sided lancets of great length, and much resembling in form the blade of a narrow sword. Each of these is grooved on the opposing faces, and the two sections pointed at the extremity and working one against the other form not only the weapon by which the prey is struck, but the passage by which the ingestion of the victim's juices is accomplished. The sharp and channelled extremities of these piercing setæ are shown at Fig. 7, and observation has satisfied me that in action they operate by a sliding action one upon the other, this being probably given by the alternate compression and dilation of the spiral muscular bundles enveloping the pharynx, as seen in Fig. 10. The two remaining setæ are thin and hollowed throughout so as to form sheaths, which, closing in on either side, protect the lancet setæ throughout their entire length. These sheaths are shown in Fig. 6 in their natural position, and the extremity of one from an allied genus is more highly magnified at Fig. 8. Towards the extremity they are more or less serrated, or sometimes provided with knobby protuberances, and the thin edges, which frequently overlap, are ribbed and notched in a definite pattern, in order,

doubtless, to assist in securing the organ in position in the body of the victims of attack.

The insertion of the setæ in the skin of the aphis or other insect being accomplished, these serrations give a secure hold, and enable the channelled lancets within, sliding one upon the other by the action of the spiral muscles at the base of the rostrum, to extract at leisure the juices of the body without disturbance or the possibility of escape for the victim. It is generally considered that these four setæ should be taken to represent the mandibles and maxillæ of the Diptera and Hymenoptera ; but this view does not seem to take cognisance of the resemblance in structure between the grooved lancets and the narrow grooved, horny *ligula* of the Diptera. It seems to me that the upper of the two lancets may represent the united and elongated mandibles, whilst the lower is most probably the representative of the ligula. All four setæ take their rise from among powerful groups of muscles, situated in either side of the head, and as shown in Fig. 10 are so divergent as to give each one an entirely independent point of support, while, centrally placed among them, the tube of the lancets is continued as a pharynx surrounded by spiral muscles, which, by their contraction or elongation, would be capable of producing a powerful pumping action exactly suitable to the action of the lancets.

The coxæ, and especially the anterior pair, are very largely developed in the *Capsidæ*, and as this feature is generally evident in the earlier stages of the insect's existence, it may often assist in determining the position of an unknown larva or nymph. The tibiæ, alike in the nymph and imago, are slender, and usually, though not always, possess a fringe of five spines, and the tarsus is in all genera three-jointed. The posterior protuberance is less prominent in the nymph than in the larva, but presents much the same features ; but the ventral surface of the abdomen, in all those *Capsidæ* which I have examined at this later stage, shows in the female an axial ridge sufficiently indicative of the future ovipositor. The tufted prominences on the upper surface of the abdomen are, in the species illustrated, marked by dark spots of irregular size, and to get a proper observation of these a specimen should be treated with potash and mounted in Canada balsam,

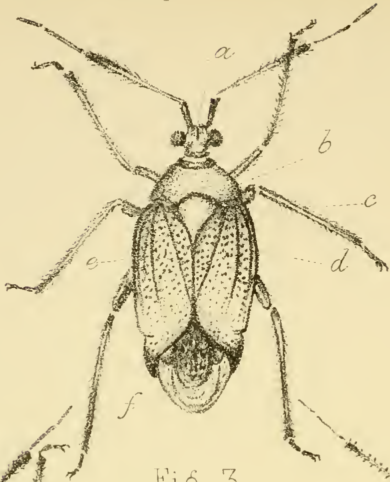


Fig. 3.

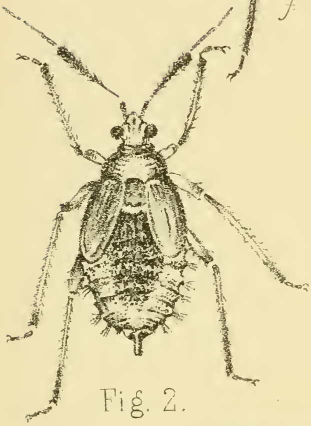


Fig. 2.

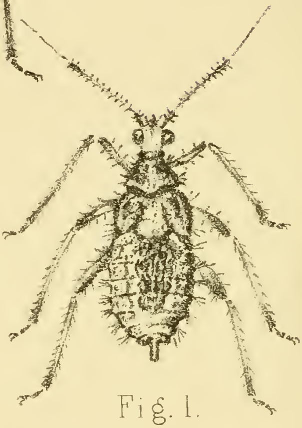


Fig. 1.

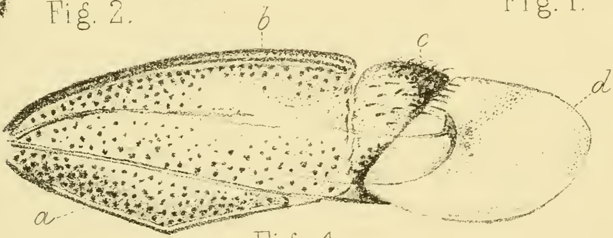


Fig. 4.

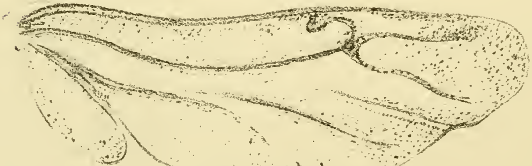
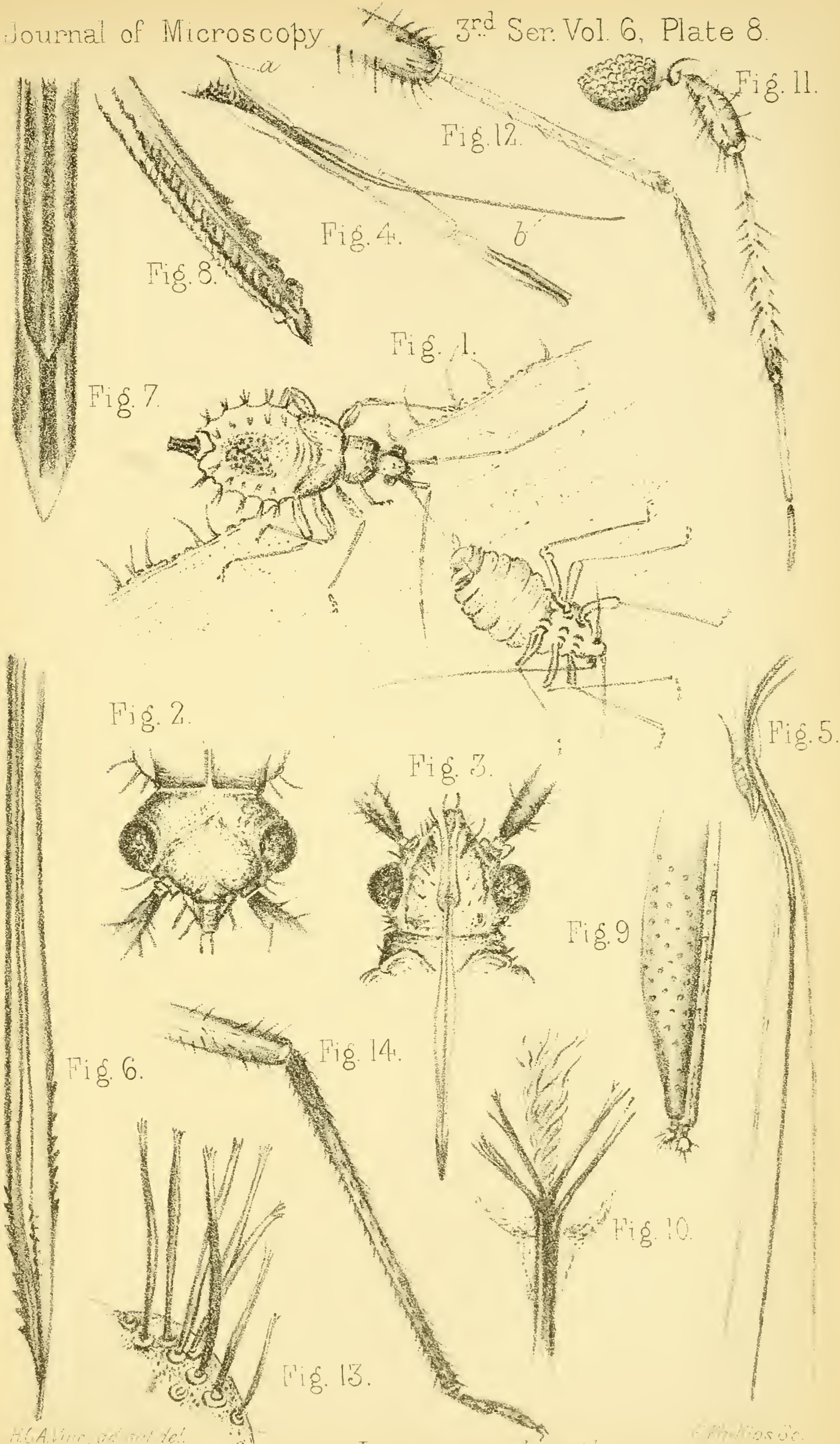


Fig. 5.

H.C.Aline ad nat. del.

F. Phillips Sc.

Capsus Lanarius.



H.G.A. Vine, ad nat. del.

Phillips Sc.

Capsus Laniarius details.

as otherwise the opacity of the insect hinders any but the lateral prominences from being apparent.

EXPLANATION OF PLATES VII. & VIII.

Plate VII.

Aphidivorous Hemiptera. Illustrations of *Capsus lanarius* (Linn.).

Fig. 1.—*Capsus lanarius*, larval stage. The stiff, flattened bristles are a very noticeable feature at this stage. The thickening of the second joint of the antennæ is not yet apparent, but the labrum and rostrum are strongly developed.

,, 2.—*C. lanarius*, nymph or pupa stage. Here the development of the wing pads, the thickening of the second joint of the antennæ, and the widening of the abdomen are very apparent features.

,, 3.—*C. lanarius*, imago. *a*, Vertex; *b*, prothorax (the upper surface seen is the *pronotum*); *c*, mesothorax (the only portion of this visible is the triangular *scutellum*); *d*, metathorax (this is not visible with the wings closed); *e*, hemelytra; *f*, membrane of hemelytra.

,, 4.—*C. lanarius*, hemelytron. *a*, Clavus; *b*, corium; *c*, cuneus; *d*, membrane. The surface of the corium is deeply pectinated.

,, 5.—One of the membranous posterior wings of same.

Plate VIII.

Fig. 1.—The attack of *Capsus lanarius* (larva) on a Pear Aphis. The capsid, coming suddenly over the edge of the leaf, has transfixed the aphis with its rostrum.

,, 2.—Head of *C. lanarius* (larva) from above. The projection of the labrum beyond the vertex and covering the base of the rostrum is very noticeable, and also the flattened bristles of the epidermis.

,, 3.—Head of same from below, exhibiting the position and formation of the rostrum.

,, 4.—The rostrum, showing towards the base the labrum, *a*, and at *b* the conjoined setæ, lifted out of the groove in the labial sheath.

,, 5.—The four setæ, removed from the rostrum; the two exterior, sheath-like setæ (apparently corresponding to the maxillæ in mandibular insects), separated from the central piercing organ.

,, 6.—The extremity of the closed setæ, as they appear in a nearly related genus.

,, 7.—The extremity of the actual piercing setæ (apparently homologues of the mandibles and ligula), showing the grooved and sliding structure.

Fig. 8.—The extremity of one of the maxillary setæ.

,, 9.—The extremity of the fleshy sheath of the rostrum, showing the minute terminal pads corresponding to the labial lobes of the diptera.

,, 10.—The muscular structure within the base of the setæ, showing the spiral arrangement of the muscles which enclose the pharynx.

,, 11.—Antennæ of *C. lanarius*, showing the enlarged second joint.

,, 12.—The two terminal joints of antenna (nymph), enlarged.

,, 13.—A group of characteristic flattened bristles, situated in tufts on the sides of the abdomen of larva and nymph.

,, 14.—Tibia and tarsus of *Capsus lanarius*.

Remarkable Trees.

IN the Old World the greatest tree is the African Baobab, and in the New World the Wellingtonia. At the mouth of the Senegal River specimens of the Baobab have been measured of over one hundred feet in circumference, though it is never more than sixty feet in height and becomes hollow at an early age. Dr. Livingstone found one in which thirty men could sleep comfortably; and Humboldt tells of one in Senegambia wherein the negroes held their meetings. Adamson has calculated that some of these trees must be at least 5000 years of age, by which time they are thirty feet in diameter.

Among curiosities there is the bottle tree of Brazil, which swells from a slender base until, at half its height, the diameter is equal to the altitude, a similar genus being found in tropical Australia.

We must mention the so-called "living stones" of the Falkland Islands, where, owing to the strong Polar wind, it is impossible for trees to grow erect, so Nature has made amends by furnishing a supply of wood in the most curious shape imaginable. Here and there are to be found in the islands singular shaped blocks of what appear to be weather-beaten and moss-covered boulders of various sizes. These boulders cannot be turned over, they being tied to the earth by roots of extraordinary strength. No other country in the world has such a peculiar forest growth, and it is impossible to work these odd-shaped blocks into fuel, because the wood is perfectly devoid of grain, and appears to be nothing but a twisted mat of fibres.—*Wm. Norman Brown in Gardener's Magazine.*

Peripatus, Myriapods, and Insects.*

VOLUME V. (the second in order of publication) of THE CAMBRIDGE NATURAL HISTORY has reached us, and we are pleased to say that all we said in a former notice in praise of the first issued volume may be said of this. The subjects throughout are treated in a most pleasing and instructive manner, and may be read with pleasure and profit by every student of Natural History.

The first chapter treats of the small class, PROTOTRACHEATA, which contains the solitary genus, *Peripatus*, a lowly organised animal and of remarkable sluggishness, with but slight development of the higher organs of sense; with eyes, the only function of which is to enable it to avoid the light. Though related to those animals most repulsive to the æsthetic sense of man—animals which crawl upon their bellies and spit at or poison their prey—is, yet strange to say, an animal of striking beauty. The exquisite sensitiveness and constantly changing form of the antennæ, the well-rounded plump body, the eyes set like small diamonds on the side of the head, the delicate feet, and, above all, the rich colouring and velvety texture of the skin, all combine to give these animals an aspect of quite exceptional beauty. . . They live beneath the bark of rotten stumps of trees, in the cavities of rock, and beneath stones. They require a moist atmosphere and are exceedingly susceptible to drought. They avoid light and are therefore rarely seen. They move with great deliberation, picking their course by means of their antennæ and eyes. . . . The antennæ are extraordinarily sensitive, and so deli-

* "THE CAMBRIDGE NATURAL HISTORY," edited by S. F. Harmer, M.A., Fellow of King's College, Cambridge, Superintendent of the University Museum of Zoology; and A. E. Shipley, M.A., Fellow of Christ's College, Cambridge, University Lecturer on the Morphology of Invertebrates.

Vol. V., PERIPATUS, by Adam Sedgwick, M.A., F.R.S., Fellow and Lecturer of Trinity College, Cambridge. MYRIAPODS, by F. G. Sinclair, M.A., Trinity College, Cambridge. INSECTS, Part I., by David Sharp, M.A. (Cantab.), M.B. (Edin.), F.R.S. 8vo, pp. xi.—584. (London: Macmillan and Co. 1895.) Price 17/- net.

cate, indeed, that they seem to be able to perceive the nature of objects without actual contact.

Chapter II treats of the class Myriapoda, a class of animals which are widely distributed, and are represented in almost every part of the world. Heat and cold alike seem to offer favourable conditions for their existence, and they flourish both in the most fertile and the most barren countries.

One of the most important characteristics which distinguish Myriapods from other Arthropods is the fact that they possess, on the posterior segments of the body, true legs which are jointed and take part in locomotion. The head is in all cases quite distinct from the body, and may be regarded as a number of segments fused together into one mass. Their heads are always provided with a single pair of antennæ and mouth appendages, consisting of an upper lip, a pair of mandibles or jaws, and one or two pairs of maxillæ.

Their internal structure has a great likeness to that of insects. The general position of the internal organs may be seen from Fig. 11, which shows a *Lithobius* dissected so as to exhibit the digestive and nervous system :—

The *digestive canal*, which is a straight tube, extends throughout the whole length of the body, and terminates in the last segment of the body.

The *heart* has the form of a long, pulsating, dorsal vessel, which extends throughout the whole length of the animal. It is divided into a number of chambers which are attached to the dorsal wall of the body, and are furnished with muscles of a wing-like shape, which are known as the alary muscles and which govern the pulsations. The chambers are furnished with valves and arteries for the exit of blood, and slits known as *ostia* for the return of blood to the heart.

The remaining chapters of the book treat of the following Orders of Insects, viz. :—Aptera, Orthoptera, Neuroptera, and a portion of Hymenoptera.

Insects form by far the larger part of the land animals of the world. They outnumber in species all the other terrestrial animals together, while, compared with the Vertebrates, their numbers are simply enormous. Yet they attract but little attention from

the ordinary observer, this being probably primarily due to the small size of the individual Insect, which leads the unreflecting to treat the creature as of little importance. . . . The largest Insects scarcely exceed in bulk a mouse or a wren, while the smallest are almost or quite imperceptible to the naked eye, and

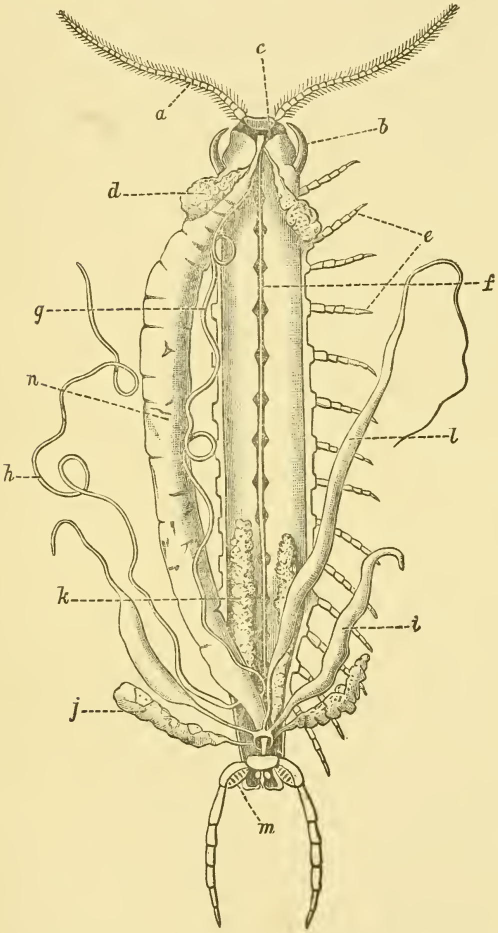


Fig. 11.
Lithobius dissected (after Vogt and Yung).

a, Antennæ ;
b, Poison-claws ;
c, Brain ;
d, Salivary glands ;
e, Legs ;
f, Nerve cord ;
g, Malpighian tube ;
h, Malpighian tube ;
i, Vesicula seminalis ;
j, Accessory gland ;
k, Accessory gland ;
l, Testis ;
m, Thigh-gland ;
n, Digestive tube.

yet the larger part of the animal matter existing on the lands of the globe is in all probability locked up in the form of Insects. Taken as a whole, they are the most successful of all the forms of terrestrial animals.

The series of rings of which the external crust or skeleton of Insects is composed exhibits great modifications, not only in the various kinds of Insects, but even in the different parts of the same individual, and at successive periods of its development.

Many of the anatomical structures have positions in the body that are fairly constant throughout the class. Parts of the respiratory and muscular systems and fat-body occur in most of the districts of the body. The heart is placed just below the dorsal surface; the alimentary canal extends along the middle from the head to the end of the body. The chief parts of the nervous

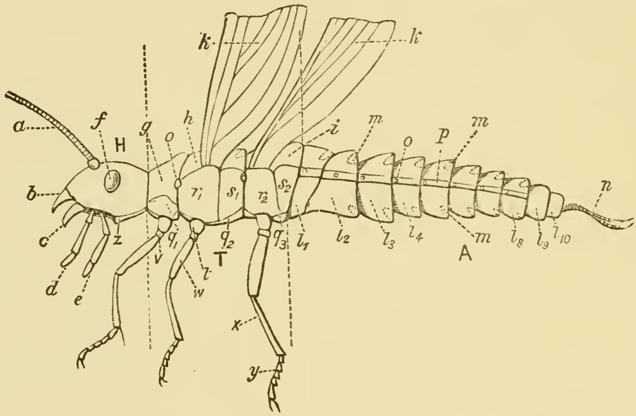


Fig. 12.—Diagram of Exterior of Insect.

The two vertical dotted lines indicate the division between *H.*, Head; *T.*, Thorax; and *A.*, Abdomen. *a*, Antennæ; *b*, Labrum; *c*, Mandible; *d*, Maxillary palpus; *e*, Labial palpus; *f*, Facetted eye; *g*, Pronotum; *h*, Mesonotum; *i*, Metanotum; *k*, Wings; *l*1 to *l*10, Abdominal segments; *m*, The internal membranous portions uniting the apparently separated segments; *n*, Cerci; *o*, Stigma; *p*, Abdominal pleuron bearing small stigmata; *q*1, *q*2, *q*3, Pro-, meso-, and meta- sterna; *r*, Metathoracic episternum; *s*, Epimeron, these two forming the mesopleuron; *r*2, *s*2, Metathoracic episternum and epimeron; *t*, Coxa; *v*, Trochanter; *w*, Femur; *x*, Tibia; *y*, Tarsus; *z*, Gula.

system are below the alimentary canal, except that the brain is placed above the beginning of the canal in the head. Fig. 13 shows the arrangement of some of the chief organs of the body, with the exception of the muscular and respiratory systems, and the fat-body.

Chapter V., which treats of the Development of Insects, is most interesting. Although eggs are laid by the great majority of insects, a few species nevertheless increase their numbers by the production of living young, in a shape more or less closely similar to that of the parent. This is well known to take place in the Aphididæ, or green-fly insects, whose rapid increase in numbers is such a plague to the farmer and gardener. These and some other cases only emphasise the fact that insects are preeminently oviparous. In illustration of this chapter we have chosen Fig. 14, which represents the larva and pupa of a bee. It will be seen that the difference between the two forms a very great contrast, while the further change that will be required to complete the perfect Insect is but slight. When the last skin of a bee or a

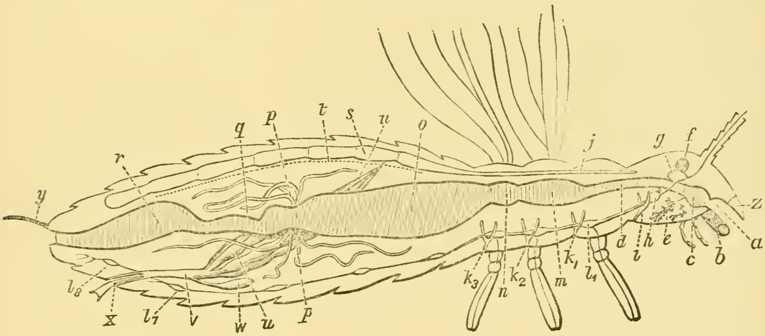


Fig. 13.—Diagram of arrangement of some of the Internal Organs of an Insect.

a, Mouth ; *b*, Mandible ; *c*, Pharynx ; *d*, Œsophagus ; *e*, Salivary glands (usually extending further backwards) ; *f*, Eye ; *g*, Supra-œsophageal ganglion ; *h*, Sub-œsophageal ganglion ; *i*, Tentorsum ; *j*, Aorta ; *k*1, *k*2, *k*3, Entothorax ; *l*1 to *l*8, Ventral nervous ganglion ; *m*, Crop ; *n*, Proventriculus ; *o*, Stomach ; *p*, Malpighian tubes ; *q*, Small intestine ; *r*, Large intestine ; *s*, Heart ; *t*, Pericardial septum ; *u*, *u*, Ovary composed of four egg-tubes ; *v*, Oviduct ; *w*, Spermatheca (or an accessory gland) ; *x*, Retractile ovipositor ; *y*, Cercus ; *z*, Labrum.

beetle is thrown off, it is, in fact, the imago that is revealed. The form thus displayed, though colourless and soft, is that of the perfect insect; what remains to be done is a little shrinking of some parts and expansion of others, the development of the colour, and the hardening of certain parts. The colour appears quite gradually and in regular course, the eyes being usually the

first parts to darken. After the colouration is more or less perfected—according to the species—a delicate pellicle is shed or rubbed off, and the bee or beetle assumes its final form, though usually it does not become active till after a further period of repose.

The remaining chapters treat of Classification, in which the various classes up to the Hymenoptera are very fully described and figured. Chapter XVI., from which we have selected our last illustration, is devoted to the TERMITIDÆ—White Ants or Termites. This chapter is throughout an exceedingly interesting one. Our space will only allow of one short extract :—

The economy of *Termes lucifugus*, the only European Termite besides *Calotermes flavicollis*, has been studied by various observers, the most important of whom are Lespès and Grassi and

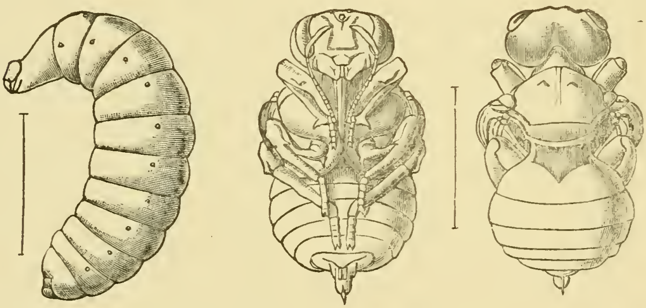


Fig. 14.—Larva and Pupa of a Bee, *Xylocopa violacea.*
A, Larva ; *B*, Pupa, ventral aspect ; *C*, Pupa, dorsal aspect. (After Lucas.)

Sandias. This species is more advanced in social life than *Calotermes* is, and possesses both workers and soldiers (Fig. 15, 2, 3). The individuals are much smaller than those of *Colotermes.* Burrows are made in wood of various kinds, furniture being sometimes attacked. Besides making excavations, this species builds galleries, so that it can move from one object to another without being exposed ; it being a rule—subject to certain exceptions—that Termites will not expose themselves in the outer air. This is probably due, not only to the necessity for protection against enemies, but also to the fact that they cannot bear a dry atmosphere ;

if exposed to a drying air, they speedily succumb. Occasionally, specimens may be seen at large; Grassi considers them to be merely explorers. Owing to the extent of the colonies, it is difficult to estimate with accuracy the number of individuals compos-

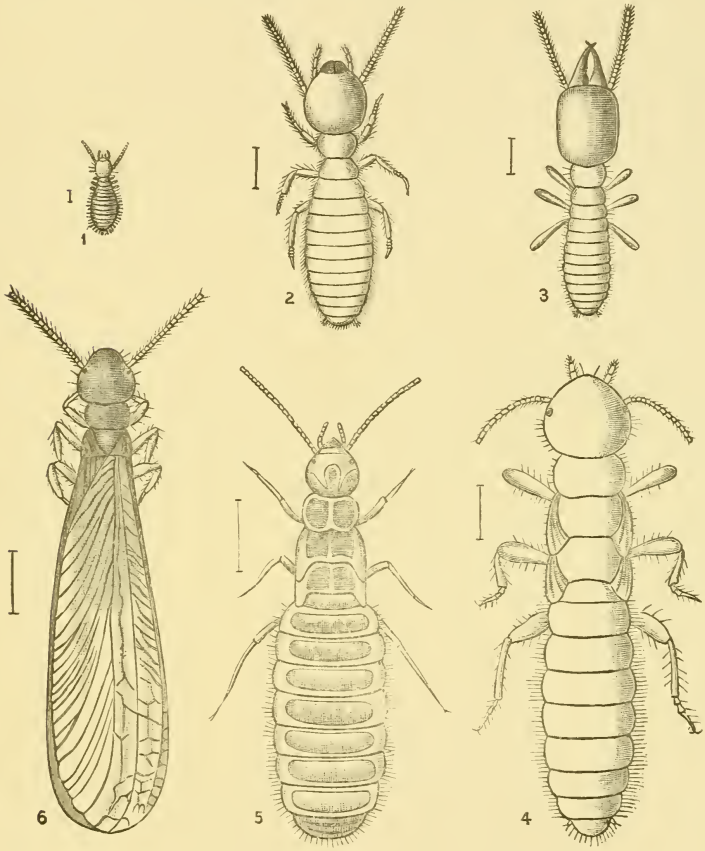


Fig. 15.—Some of the forms of *Termes lucifugus*.

1, Young larva; 2, Adult worker; 3, Soldier; 4, Young complementary Queen; 5, Older substitute Queen; 6, Perfect winged Insect. (After Grassi.)

ing a community, but it is doubtless a great many thousands. Grassi finds the economy of this species in Italy to be different from anything that has been recorded as occurring in other

species; there is never a true royal pair. He says that during a period of six years he has examined thousands of nests without ever finding such a pair. In place thereof there are a considerable number of complementary queens—that is, females which have not gone through the full development to perfect insects, but have been arrested in various stages of development. Nos. 4 and 5, Fig. 15, show two of these abnormal royalties. No. 4 is comparatively juvenile in form, while No. 5 is an individual that has been substituted in an orphaned nest, and is nearer to the natural condition of perfect development. We have no information as to whether any development goes on in these individuals after the state of royalty is assumed, or whether the difference between these neoteinic queens is due to the state of development they may happen to be in when adopted as royalties. Kings are not usually present in these Sicilian nests.

In reference to the above volume, we state with confidence that each author has carried out his share of the work in a very thorough and masterly manner. The remainder of the Insects will be completed in Vol. VI. The illustrations, as will be seen from those kindly lent to us by the publishers, are first-class, as are also the letter-press and general get-up of the work. Our best thanks are due to Messrs. Macmillan and Co. for the use of the blocks and for permission to make the above extracts.

PROTEIDS OF WHEAT.—Miss M. O'Brien has an exhaustive paper in the *Annals of Botany* (Vol. IX., 1895, p. 171) on the distribution of the functions of the aleurone grains in wheat. She supports the theory of Weyl that glutin is formed by the action of a ferment on the myosin, which is the chief proteid of wheat. The aleurone-grains do not, in the *Gramineæ*, present that degree of differentiation in which the mineral matters are sharply separated off as a globoid from the proteid constituents of the grain, only the membrane is here differentiated. The theoretical view is advocated of there being in flour one mother-substance which readily undergoes hydration, giving rise to gluten.—*Pharm. Journ.*

The Discovery of Rontgen: Some Details of the Apparatus and Original Experiments.*

By Hugo Muller (Berlin).

SLOWLY but uninterruptedly, in general, science proceeds. One stone is laid upon the other, and the building grows more and more; but from time to time a shock as of lightning will shake the old, proud scientific construction, including such discoveries as that of the rotation of the earth, of electricity, of the spectral analysis, of the telephone, and so on. Such a discovery was made some weeks since by a German, Prof. Rontgen, at Wurzburg. Many journalists have written about this discovery, some with belief, some with scepticism. We are enabled to give our readers illustrations made after Rontgen's descriptions, which prove that he has not claimed too much. The experiments of Rontgen were repeated in the electro-technical laboratory of the Royal Polytechnic at Charlottenburg, Berlin, by Professor Dr. Slaby and his assistant, Klingenberg. I assisted at these experiments, and will endeavour to describe them so that anybody possessing the necessary apparatus (which is very costly) will be able to repeat them, and to convince himself of the wonderful invention. The principal apparatus is an evacuated glass globe (or Crookes' tube) of 10 to 15 cm. diameter, through which a strong electric current is sent.

A vacuum is formed in the glass globe, in the first instance, by an air-pump with water, afterwards with mercury, as invented by Sprengel. If the vacuum is not complete, the electric current produces in the evacuated tube the so-called "Geisler" light, which is visible to the human eye.

As the evacuation (exhaustion) proceeds, the light diminishes, and, at a certain point, it totally disappears. In its place the glass of the tube or globe becomes phosphorescent with a pale green intermittent light, this phenomenon being produced by the invisible

* Reprinted by kind permission of the Editor of *The Amateur Photographer*, to whom also we tender our thanks for the use of accompanying block.—Ed.

rays from the cathode. The phosphorescence of the glass is only a secondary appearance produced by the cathode beams. Before 1879, Goldstein, of Berlin, and Hittorf, of Munster, observed these beams from the cathode, but they received the name of Crookes-light because, in a report before the British Association, Crookes did not name Goldstein and Hittorf, though he had acknowledged their priority in the *Chemical News* of the 30th of May, 1879. The cathode rays, about which further instruction may be found in the *Annalen der Physik and Chemie*, 1895-1896 (Lenard's observations), are different from the X rays of Prof. Rontgen. The X rays, which appear only if the vacuum is driven to the highest degree, are not turned from their course by an electro-magnet, whereas the ordinary cathode rays are so turned. The cathode rays also do not pass through the glass of the globe, whereas the X rays pierce the glass, and spread in the open air. The nature of these Rontgen rays is not yet quite known; one would be inclined to believe that they are ultra-violet light, but that they are not refrangible. The lens or the prism has no influence on the X rays; they

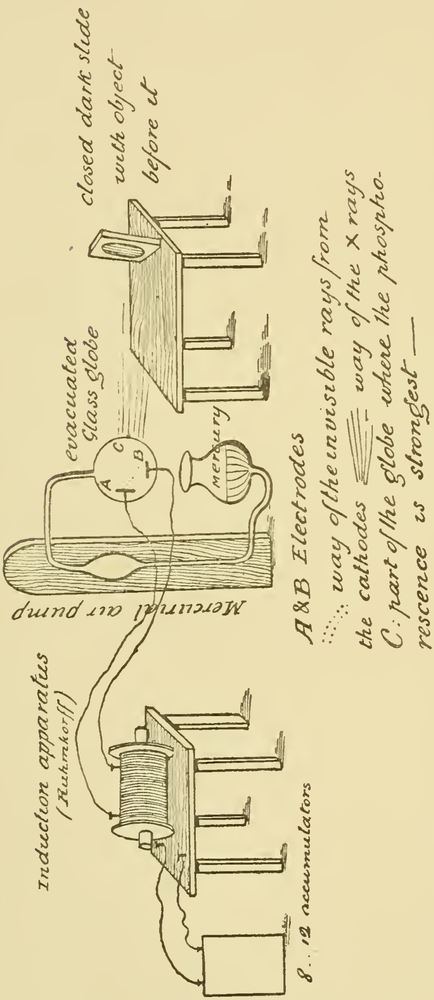


Fig. 16.

pierce *all* materials in some way—organic tissue, flesh, wood, paper, and so on; therefore we suppose that the question here is of longitudinal vibrations of the ether, whereas our ordinary light consists of transverse vibrations. By chance, Rontgen observed that the X beams made an impression on a photographic plate. We may not think that the visible green phosphorescent light produces this effect, for though the glass globe was enveloped in a black opaque substance, so that no visible light pierced the cover, an impression was nevertheless made on the sensitive plate. The experiments which should prove all these miraculous qualities of the X beams were quite recently made in the Polytechnic School at Charlottenburg, and daylight was excluded from the laboratory only while the sensitive photographic plate was being put in the dark slide. Eight to twelve great accumulators of two volts tension each were connected with a strong induction apparatus (Ruhmkorff), giving sparks of 30 cm. length. Copper wires conducted the electric current to the electrodes of the glass globe, which were kept joined to the mercurial air pump, to continue the exhaustion of the air during the experiments. It seems the quality of the glass influences the success of the experiments, for of a series of globes made by the glass-blower only two proved suitable. The ordinary evacuated (exhausted) glass globes of commerce were not suitable, probably because the vacuum was not sufficiently complete. The right degree of evacuation of the air, the pressure of which must not exceed a thousandth part of the atmospherical pressure, is one of the necessary conditions.

During the exhaustion of the glass globe a photographic plate was put into the dark-slide in a dark-room. It is best to use a dark-slide made of pasteboard, because the metallic parts of a wooden one absorb the rays coming from the glass globe. The object to be photographed was tied on the closed dark-slide by silken threads, and placed with it in front of the glass tube. If we wished to make an image of our hand, we placed the dark-slide containing the plate in front of the glass globe at a distance of 25 cm., and put the hand on the pasteboard, no lens or photographic camera being used. An exposure of 25 minutes was sufficient. If the distance is greater, the exposure must be longer, as the X rays diminish with the quadrate (square) of the distance.

The plate was developed with metol and hydroquinone, and showed an exact photograph copy of the skeleton of the hand, on the middle finger of which we clearly saw a ring, which the rays (though passing through the flesh of the hand and the pasteboard) had not pierced. The ring was a band of lead, the ends of which were not quite joined. A mouse was photographed in the same way without removing the hair or the skin. The invisible X rays produced an admirable image, showing all the small bones of the body, as well as the vertebræ of the tail. In order to see in what degree different materials were penetrable, we fastened a piece of metal, a piece of glass, and a lead pencil on the surface of the dark-slide, and were astonished to find that the glass absorbed the rays as much as the metal and the graphite in the pencil, the wood of the latter being pierced without difficulty. We also placed a book of 100 and more pages in the way of the invisible beams, but it was no hindrance. Finally, photographs were taken of a hen's leg and a pigeon, requiring exposures of an hour or more.

The experiments were not without danger, because of the strong electric currents, but were successful, not only in the laboratory of the Polytechnic, but also in that of the Urania (popular physical institute in Berlin) and of the Physical States Laboratory at Hamburg. In the laboratory of the Polytechnic we were successful in modifying the proceedings so that the exposures were shorter and the images more distinct.

By this new discovery science in general, but especially medicine, will benefit. If, for instance, a ball has entered into a soldier's leg, its place and the injury to the bone will be easily found by the X rays. We need only place the closed dark-slide (with the gelatine plate) under the injured leg, and send the X rays from the glass globe through it; the bone and the ball will then appear as silhouettes on the photographic plate. Practical results have recently been obtained in some hospitals. A young lady had been unable, from some unknown cause, to use her right hand for a long time. A photograph of her hand was made, and the negative showed a white spot caused by a piece of glass through which the X rays had not passed, and which was removed by a simple operation. When the invention is perfected we shall be

able to find gall-stones and other injurious bodies whose discovery is, at present, attended with great difficulty.

The following observations help to explain how the image on the sensative gelatine plate is produced. Rontgen observed that even when he enclosed the vacuum tube in a dark box of pasteboard, a screen overlaid with barium cyanide of platinum began to phosphoresce as soon as the elecric current passed through the tube. The astonishing phenomenon that invisible rays producing phosphorescence passed through the black pasteboard box, induced Rontgen to try other materials, and he found that certain salts of lime, mineral salt, ordinary glass, also phosphoresced. It is therefore probable that the photographic image on the plate is produced by the phosphorescence of the glass, or perhaps, of the gelatine, which flames up the more vivaciously the more the object before the dark-slide, which lets pass the X rays, is penetrable.

Professor Conrad Rontgen was born at Lennep, March 27th, 1845. In December, 1870, he became assistant at the Physical Institute of Wurzburg, where he remained till May, 1872, and then went as assistant to the Physical Institute of Strassburg. A year after he was appointed professor at the Academy of Hohenheim. In 1876 we find him at Giessen, and in 1888 he became director of the Physical Institute of the University of Wurzburg. He has published many scientific essays, which are the results of much study and research.

When the Emperor William II. heard of this important discovery he ordered Rontgen to come to Berlin, where he performed his experiments before His Majesty, who presented him with a high decoration (Krunenorden) for the great service he had rendered to science, the full results of which cannot yet be ascertained.

Good Liquid Cement.—The following is said to make an excellent liquid cement :—To a solution of chloral hydrate in water dissolve gelatine to the required consistency. The cement thus made is said to have great adhesiveness and to remain indefinitely unchanged. Ordinary glue may be used instead of the more expensive gelatine; it is equally strong.

Selected Notes from the Postal Microscopical Society's Note-Books.

Plate IX.

Diatoms.—I send this box out with great diffidence. Specialists are often tabooed and boxes of their slides set aside. But as some of our members have, in the "Notes," asked me to circulate some Diatoms, I have ventured to do so. These *may* turn the serious attention of some to this most fascinating study; if they do, I shall be more than repaid.

Diatoms are "unicellular Algæ," having a vegetable structure, which has the power of secreting the liquid silica which comes down from the mountains or stony plains through the rivers into the sea, and depositing it in themselves. These valves appear usually to consist of two or more layers, marked with the most exquisite lines or points. They have been called "Brittle-worts," from their tendency to break up into fragmentary frustules; this is also the meaning of their Greek name, "Diatom." Their function is to suck out the carbonic acid there is in the water, using the carbon for themselves, and setting free the oxygen. By secreting the liquid silica, they make the water purer and more useful.

They exist, and have existed, in countless millions; in some parts even the ice is made brown by the quantity of diatoms thrown upon it; they are found in fresh water, brackish water, and sea water, in marls, in dried-up lakes, and in sedimentary rocks. Though so small, they are of every conceivable shape, with striæ that run to 130,000 to the inch, as in *Amphipleura pellucida*. Upwards of 4,000 forms have already been catalogued. They are found in strata dozens of miles in length, and often many feet in thickness; indeed, a deposit of diatomaceous earth was found in Victoria Land 400 miles long by 120 wide. The Columbia river runs through two precipices, 500 ft. high, almost entirely diatomaceous. The "Polishing Slate" of Bohemia, "Turkey Stone," and "Rotten Stone," are chiefly composed of diatoms. "Kieselguhr," used for dynamite, and "Sozodont" tooth powder are mainly diatomaceous. The famous Oamaru deposit in New Zealand is more than two miles in length; near its southern end it

may be about five feet thick; towards the north end it is over twenty feet thick.

It is obvious that out of hundreds of slides I can only send round a few specimens. These shall be chosen so as to show those who know little about diatoms their extreme beauty, both as separate mountings, and as "spread" slides; the latter will show how the various forms are commingled. A few "test" slides will also be added for those who possess "high powers."

I need hardly add that those who want to see Diatoms in their native beauty with their endochrome should not fail to get some diatomaceous material from some sluggish stream or marine marsh, and look at them in a drop or two of water on a slide with a cover-glass over, and view them with a ½-inch objective as they move—vegetables moving!—they will have a treat.

If these slides convey to many of our members the same pleasure that for years they have done to me—an old clergyman in weak health—I shall be well repaid. They have been obtained from various sources, mainly from my old friends, E. Grove, Esq., and Major Lang. The former is well known for his Paper on the "Oamaru Deposit"; the latter as one of the most splendid mounters of "separate" forms. Some of the slides require at least ¼-inch objective.

Many persons give the whole of their leisure to the study of Diatoms; therefore, though they may be little known to some of our members, those who have taken up the study must be borne with if they say that they find in it a great satisfaction.

When one thinks of the prodigality of beauty that is around us, and which no eye of man perceives, one sees an inner meaning in the words of Rev. iv. 11—"For *Thy* pleasure they are, and were created."

Description of Slides.

Heliopelta (Sun Shield).—This is one of the class Actinoptychus, and one of the most beautiful of the discoid forms. The structure of the valve appears to consist of an inferior layer, containing large cavities or areolæ, which on the elevated compartments of the valve present the appearance of hexagonal cells, and in the intervening compartments, of irregular circular cells; and of

a superior layer, covered with fine lines of dots, crossing each other diagonally at a distance apart of about 1/30,000th of an inch. The central part and the small marginal spaces at the ends of the radial lines appear to be of solid silex, destitute of markings. The radial divisions range from six to twelve. See *Carpenter's Microscope*, 6th edition, p. 350, and Pl. I.

Aulacodiscus orientalis.—Another of the beautiful discoid forms. so called from having "furrows" running from the centre to the margin, at the end of which come *inflated tubercular processes*, varying in number.

Triceratium formosum.—The *Triceratia* are also another very beautiful class of very varied form; sometimes they are square, not triangular, The projections at the edges are prolonged in some species into horns; in others, they are tubercular elevations.

Pleurosigma formosum.—One of the most elegant of Diatoms. The *Pleurosigma* are separated from the genus *Navicula* in having a lateral sigmoid curvature. The striæ by which the valves are adorned range from 20,000 to 100,000 to the inch. *Pleurosigma formosum* is said to have 37,000 for the transverse and 30,000 for the diagonal markings. These are clearly seen by a ¼-inch objective.

Oamaru Selection.*—This slide contains the following:—*Aulacodiscus margaritaceus*, var. *Debyi; Triceratium Nova Zealandicum; Stephanopysis valida; Biddulphia Tuomeyii; Triceratium glandarium; Triceratium majus; Triceratium Nova Zealandicum; Kittonia elaborata*—this last is one of the special forms of Oamaru deposit.

River Lea, Freshwater Deposit.—Some of the leading forms are:—*Epithemia gibba*, *turgida; Navicula gracilis*, *limosa; Nitzschia angustata*, *linearis*, *sigmoidea; Pinnularia nobilis*, *viridis; Pleurosigma attenuatum* (abundant), *acuminatum*, *Spencerii; Stauroneis Smithii* (rare); *Surirella biseriata bifrons; Coscinodiscus lineatus*, an intruder. These intrusions can scarcely be avoided.

* We enumerate the principal diatoms seen on these slides to show what forms are usually found in the various deposits.—Ed.

Berg-mehl (Mountain meal, Norway).—Said to be the meal with which peasants in times of scarcity satisfy their hunger when mingled with their flour. *Pinnularia nobilis* (abundant)*; Pinnularia divergens ; Eunotia ; Gomphonema ; Stauroneis.*

Holles Cliff, Virginia.—This is one of the finest Virginia series. It contains *Coscinodiscus asteromphalus, apiculatus, perforatus, craspedodiscus ; Actinocyclus Ehrenbergii ; Actinoptychus omphalopelta ; Triceratium undulatum.* The *Antinocycli* are generally iridescent, with low powers.

"Challenger" Expedition Dredgings, 1950 fathoms.—This slide is most interesting, as showing how the strata at the bottom of the sea are still being formed. Though much is Radiolarian ooze, still, a portion is Diatomaceous. Some of the forms are very prevalent, *Coscinodiscus lentiginosus* having a little "fleck" on the margin, having a bit of *Fragilaria Antarctica* lying upon it, the "fleck" showing a little below, common ; *Coscinodiscus Africanus*, var. *Wallichiana ; Cosc. actinochilus ; Actinocyclus Oliverianus*, common ; *Fragilaria Antarctica*, very common.

Sponge Sand.—This slide shows how diatoms prevail everywhere. They were taken out of some common sponge sand, which can be got from any chemist. The following is a list :—*Auliscus cœlatus ; A. cœlatus*, var. *mergens ; Navicula crabro ; Endictya oceañica*, common ; *Cerataulus Smithii ; Navicula lyra ; N. Lesinensis ; Campylodiscus limbatus ; Navicula quadriseriata.*

Ananino Polishing Paste (Syzran, Simbirsk, Russia).—Some of these forms are very striking, especially the *Actinoptychi, Aulacodisci*, and *Triceratia.* The following are on this slide :—*Actinoptychus heterostrophus ; Actin. Simbirskianus ; Actin. seductilis ; Aulacodiscus quadrans ; Aula. probabilis ; Triceratium Weissii ; Cheloniodiscus Ananinensis.*

Oamaru Deposit.—This is the well-known New Zealand deposit, so carefully described by Messrs. Grove and Sturt in the *Quekett Journal*, 1884—1889. It forms a most interesting study, as so many of the forms are peculiar. Amongst them are :—

Rutilaria radiata, with zone ; *Coscinodiscus spiniferus ; Triceratium coscinoides ; Tric. unguiculatum ; Navicula sparsi-punctata ;*

Asterolampra decora; Trinacria ventricosa; Triceratium plenum; Aulacodiscus crux. A. CLARKE-SMITH.

The fact that the "Polishing Stone of Bohemia," mentioned by Mr. Smith, is chiefly composed of Diatoms, is rather suggestive to microscopists of what happens to people's teeth when they use "Sozodont."

Is it true that *P. Formosum* ever possesses "striæ" or any other markings of the extreme tenuity of 130,000 to the inch? I studied them for some years hopefully in search of the solution to the markings because they were so large. Carpenter mentions them as tests for low powers. But it is to be much desired that Mr. Clarke-Smith had given us some specimens of what would be something more than that. No wonder my old friend is such an enthusiast on Diatoms when he has such friends to send him information on the latest and choicest gems.

I cannot say all my enthusiasm survives. I greatly admire them, but cannot help thinking there is a lot of waste time spent over classification. I believe there will come a time when that will be abandoned and a simpler process substituted for the more laborious one.

I entirely endorse what my friend suggests. Get them living out of the dykes and highways for yourself, and directly you get home set to work, and see them move with your own eyes. It will be an eye-opener on the subject of the movement of *Vegetables!* However, some seem so sure about it that I suppose there is no more to be said. Still, I notice that Mr. A. Smith has doubts on the point; but I know that his views on the subject are expressed in his second paragraph. For myself there is left no alternative but to come to the conclusion that some sort of vegetables, especially in the lower grades of life, have the appearance of being very knowing things.

As to the beauty of the forms, it has always seemed to me that Practical Astronomy has in some way its analogue in the microscopical study of diatoms. I also hope we shall have a further selection at some future time from Mr. Clarke-Smith's cabinet.

LIONEL BARTLEET.

Mr. Bartleet has misunderstood what I said about markings. I did not say that *Pleurosigma formosum* had markings up to 130,000, but that some had. I have, however, at Mr. Groves' suggestion, altered my statement, making them to run up to 100,000th of an inch, *Amphipleura pellucida* 93,000; *Navicula subtilissima* has 112,000. A. Clarke-Smith.

Having lately spent a good deal of time upon diatoms, the present box of slides presents to me great interest. To draw diatoms would be labour of love and infinite patience. A much more ready way is to photograph them, and no structures lend themselves more readily to the process than diatoms. A photograph of *Coscinodiscus* shows the areolated appearance of this diatom, as seen with the ¼-inch objective. The appearance thus shown is called primary structure, and to those not accustomed to examine diatoms it would seem unnecessary to examine such a diatom with the higher power. Another photograph shows a portion of the same diatom made under a 1/12th oil immersion lens. The diatom frustule is slightly arched on the surface, so there is only a portion of it can be brought into focus at one time with such a high power. The centre or peripheral portions are therefore out of focus, the median zone being more or less in focus. In this portion other structures are shown. Around the primary areolatures are seen secondary areolations, and in the centre of the primary areolations the appearance of structure which under the magnifying power (950 to 1000 diameters) cannot be adequately defined. With the latest apochromatic objectives of Zeiss, giving a magnifying power of 2000 to 3000 diameters, the structure in the centre of the primary areolations is shown to be an exceedingly fine cribriform plate. These secondary areolations and cribriform plates are often spoken of as the "ultimate structure" of the diatom. But who shall say that this is ultimate structure? This can only be decided when lenses have been produced possessing over those which we have at present in our possession, still wider angles and proportionate power.

I enclose also a photo of a well-arranged group of diatoms * in my possession, as seen by a dark-ground illumination. Besides

* We regret that we cannot reproduce these photographs.

diatoms, it contains plates of Synapta and wheels of *Chirodota violacea.* It is an extremely pretty object when viewed under the microscope, many of the diatoms being iridescent. Some may look upon such a production as waste of time. If of no further use, it stands as a testimony to a wonderful amount of patience, labour, and dexterity. I introduce it to show what may be done with diatoms by enthusiastic diatomists. J. R. L. DIXON.

Diatomaceous Material, To Treat.—Mr. Allen has asked me to give my method of treating Diatomaceous Rock, such as Oamaru, etc. I give that which Mr. Grove (of Oamaru renown) has given me. It may not prove of much use to our advanced manipulators, but it may be useful to those who are beginning to work among Diatoms—that most fascinating study.

Break up the rock with a knife (or otherwise) into thin slices. Get a little sulphate of soda (Glauber's salts), and cover some of the slices with the salt heaped up, in a small evaporating dish; sprinkle over it a very few drops of water; heat over a lamp till the salt melts. Take away the lamp and let it all crystallise; if it does not, drop on a dry crystal, and it instantly will do so. When cool, put in a little water and warm again, and if it does not fall into pieces evaporate the water, and let it crystallise again; then wash well and boil in sulphuric acid, etc., as usual. After good washing, boil again with a very small bit of caustic potash for two minutes only, and then pour into dilute muriatic acid. It should then be clean. In lieu of an evaporating dish, the top of a cocoa-tin may be used, and the whole put on the bars of the fire-grate.

Decanting.—It is here that the trouble begins. Get some small beakers about an inch and a-half in diameter and three inches deep. If there is coarse, heavy sand, give half a minute each time to settle. Do not pour off too closely at first, and after two or three decantings you will be able to pour off clear. When the water becomes quite clear, stop and examine the sand to see if there are any large diatoms in it. If not, throw it away, and when the decanted stuff is quite settled down in the large vessel, into which you have poured your decantings, pour off all the water you can without disturbing the bottom, and then giving the vessel a good shake, pour the sediment back into the small beaker, and repeat the decanting process at two minutes' interval. Proceed as

before, and then decant again at five minutes; and if the diatoms are very small, at ten minutes. The dealers prepare large quantities at a time. They get rid of the coarse sand by "rotating," and of the light sand by filtering through fine gauze. The great point is to have the stuff *properly* cleaned before decanting and rotating, so that you have *clean* sand and *clean* diatoms. But you cannot get such stuff as Oamaru clean and bright with acid only. It must be boiled up afterwards with alkali, either carbonate (in which case you must boil it for a considerable time), or caustic (in which case you must use a very small piece and only boil for a minute or two); but the material must be bright and clean before you can separate densities properly. Should the flocculent matter not disappear, try the Liquor Ammonia process. Pour off the water from the deposit closely, put about half-an-inch of *Ammonia fortissimum* into it, shake it well, leave it standing for a day or two (at least twenty-four hours), dilute it well with water, and then pour in enough muriatic acid to neutralise the ammonia. Shake vigorously before decanting several times in distilled water.——*Another plan.*—After washing away the sulphuric acid, boil with common soda, and then while still hot neutralise with muriatic acid; wash and repeat the boiling with soda, etc., until all the flocculent matter has disappeared. It should then be well shaken in a bottle and decanted as before. But, oh, the patience required for this work!

By the courtesy of our Hon. Secretary, I am able to add some additional Notes, taken from my second Box of Slides.

Therein I endeavoured to show that we must no longer arrange diatoms by their *shapes*; that increase of knowledge brings increase of accuracy. I illustrated this by the genus *Stictodiscus.* Formerly *Triceratium parallelum* was arranged in the genus *Triceratium.* It is now removed from that class, and is put under *Stictodiscus*, which now assumes either a discoidal, or triangular, or quadrangular form. Hence, *Stictodiscus Californicus* may be *S. Californicus*, discoidal form; or *S. C. forma trigona*; or *S. C. forma trigona*, var. *gibbosa*; or *S. C. forma quadrata.* The other discoidal forms were *S. C.*, var. *areolata*, *S. Hardmanianus*, and *S. nitidus.* I may add the description of these as then sent.

Stictodiscus Californicus has large puncta somewhat remotely

scattered around the centre of the disc, and then passing in rays of *single* puncta to the margin, near to which there is often a double row. Sometimes the puncta at the centre are more clearly aggregated. The typical form is to be found in any of the Californian deposits.

S. Calif., var. *areolata*, has a secondary set of areolate or reticulate markings, which appear in focussing down a little.

S. Hardmanianus.—The radiating compartments are very numerous, and the rays towards the outside consist of five or six rows of minute granules, and round the centre are usually one or two circles of small granules; the puncta are not so large and the lines between are longer.

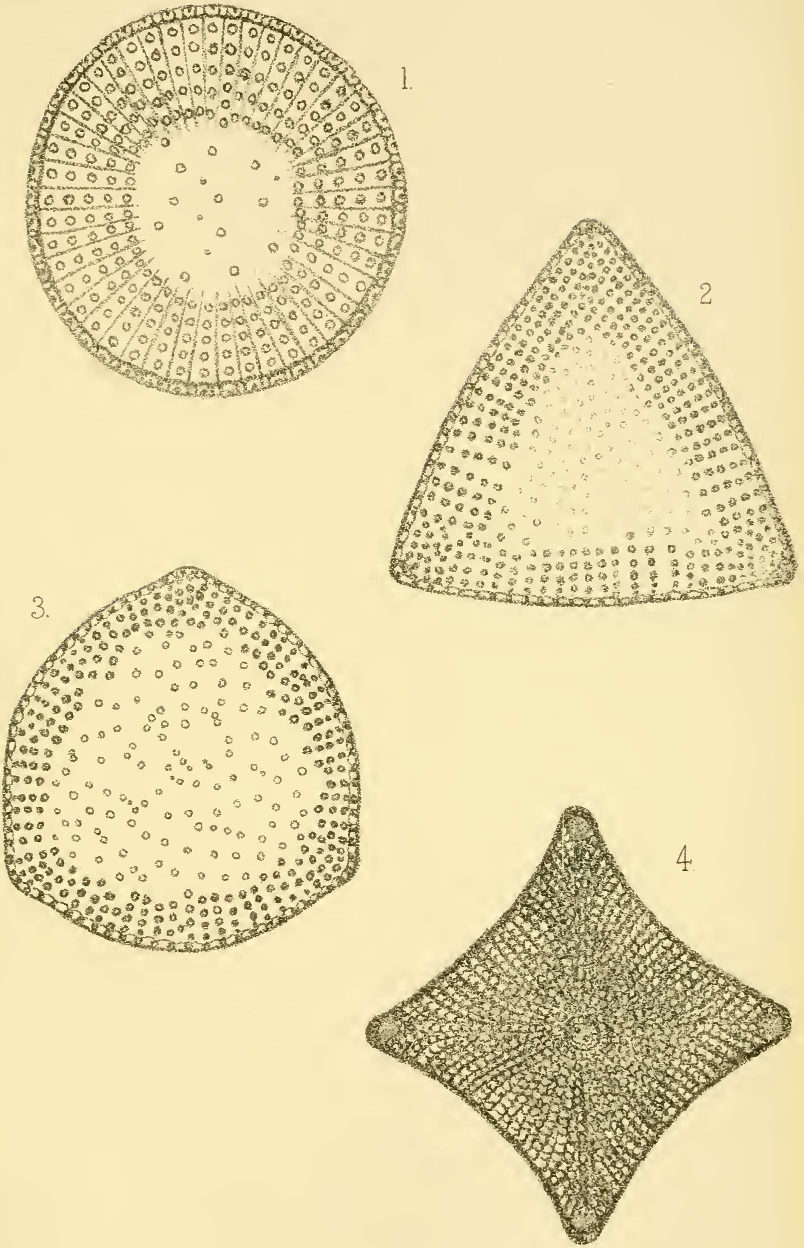
S. nitidus is dotted over sparsely with large shining puncta, giving it a brilliant appearance. A. CLARKE-SMITH.

DESCRIPTION OF PLATE IX. *Stictodiscus.*

No. 1.—*S. Californicus.*
No. 2.—*S. parallelus f. trigona.*
No. 3.—*S. parallelus f. trigona*, v. *gibbosa.*
No. 4.—*S. parallelus f. quadrata.*

Breeze Fly, Foot of.—The "Foot of the Fly" is a subject to reason upon from analogy, as it is so small an object, and a fly's walking is so impossible to observe that I do not see how it can be "settled" positively either way.

The Breeze-Fly, *Tabanus Bovinus*, is one of the Gad Flies. This family has three pads to their feet. I think some other flies have also, but am not sure. I certainly believe the ends of the hairs on the skinny pad are all "hooked." I do not see the expansion at the end, except when the end is out of focus. I can quite believe in a viscid fluid to help to make the vacuum secure, but I cannot think that enough is poured out to stick the fly's foot to the glass, and that then the fly can wrench the feet away quickly enough to walk as it does. I allow that the adhesion in a vacuum is a strong argument against the sucker theory, but a real vacuum is very difficult to get, and a very partial one would support a fly, I think. Then old flies (or, rather, weakly ones) might have their feet stuck to the glass by the fluid and not be able to take them up, though they use a sucker generally.



F. Phillips Sc.

Diatoms.

Gosse, in his *Natural History of Reptiles*, speaks of the Ghecko lizard, and on p. 86 describes the structure of the under side of the toes as enabling them to cling to inverted surfaces *as House flies do*. He says:—"The mode in which this is effected we do not thoroughly understand; but we may conjecture that it is by the raising of these imbricated plates by muscular action, so as to form a vacuum beneath the sole, when the pressure of the external air causes the toe to adhere firmly to the surface." Gosse uses the leather sucker a few lines further on as an illustration. The Ghecko can, when alarmed, move very fast. *

I do not profess to see hooks on the hairs of all fly's pads; they are not so easily to be seen on the Blow-fly's foot. I consider the foot of the Breeze-fly as one of the best examples of "hooked hairs" on the pads. I believe the Drone-fly and the Dung-fly have straight hairs. The Ophion-fly has no hairs at all, I think. The pad appears quite bare of them, and I think the pad of the Wasp's foot is without hairs, and if so they cannot adhere by means of a fluid poured out of expansions at the end of hairs.

W. Locock.

I have carefully examined this slide with 1/12th o.g., and cannot satisfy myself as to there being a single hooked hair. The appearance is, in my opinion, due to the bulbous or blunted end of the hair from which the viscid fluid is exuded, and the action of reflected light in the lumen of the hair gives a hooked resemblance when the object is out of focus. I have observed the same hooked appearance in some vegetable hairs, which poured out an adhesive or sticky substance. R. S. Hudson.

I cannot imagine what use hooked hairs would be if they exist to a fly in walking upon glass, as we cannot detect any irregularities on ordinary glass slips, even with high powers. To be of any use these hooked hairs must catch in some irregularities, and not only catch, but must also hook around the irregularity to be of any service. Compare the relative proportions of the foot-pad hooks and the glass to an ordinary black beetle and a sheet of paper. Although the beetle can climb up a white-washed wall, a papered or painted wall puzzles him, and in the cockroach the hooked claws are assisted by spurs on the elbows. From the

above I should think the vacuum theory the most tenable. I believe the hairs are *curved* at their extremities, as one frequently finds in the case with all slender filaments; but I cannot think those curved hairs would be sufficiently stiff to act as hooks. Some time sinee I examined the parasite of the House-fly alive, and think I sent a sketch showing the vacuum producing arrangements in their feet. In their case the movement of attachment and detachment was instantaneous, and I could not discover any sign of a gummy matter on the glass. If a gummy substance were used to assist the walking of a fly, we might hope to find footprints on polished glass. I have, however, never heard of this discovery. T. R. BARRETT.

I have examined the slide, "Foot of Breeze Fly," with 1/16th immersion o.g., and am satisfied that some, but not all, of the hairs are curved towards the extremity, but whether sufficiently to be of service in grasping irregularities, I am not able to give an opinion. The tubular character of the individual hairs can clearly be made out. ANNIE PENNINGTON.

I think these hairs are well seen with a low-angled ¼-in. o.g., especially on a dark ground; there are no "hooks," the hairs are slightly curved, but apparently only sufficient to make the ends perpendicular to the surface walked on; the ends appear as blunt as if cut off with a sharp instrument. This class of object is seen better when prepared in glycerine. Balsam renders them too indistinct. R. SMITH.

The why and wherefore a fly clings to polished surfaces, such as glass, is a subject very much unsettled, and yet high authorities seem to agree somewhat. Dr. Carpenter says:—"The foot is furnished with a pair of membranous expansions termed pulvilli. These are beset with numerous hairs, each of which has a minute disc at its extremity. This structure is evidently connected with the power which these insects have of walking over smooth surfaces in opposition to force of gravity, yet there is considerable uncertainty as to the precise mode in which it ministers to this faculty. Some believe that the discs act as suckers, the insect being held up by the pressure of air against their upper surface when a vacuum is formed beneath; whilst others maintain that

the adhesion is the result of the secretion of a viscid liquid from the underside of the foot. Careful observations by Mr. Hepworth (*Quarterly Journ. Micro. Sci.*) have led him to a conclusion *which seems in harmony with all the facts of the case*—namely, that each hair is a tube conveying a liquid from a glandular sacculus situated in the tarsus, and that when the disc is applied to a surface, the pouring forth of this liquid serves to make the adhesion perfect. That this adhesion is not produced by atmospheric pressure alone is *proved by the fact that the feet of flies continue to hold on to the interior of an exhausted receiver;* whilst, on the other hand, that the feet pour forth a secreted fluid, is evidenced by *the marks left by their attachment on a clean surface of glass.*" Mr. Barrett (p. 201) seems never to have heard of this. Dr. Carpenter continues :—"Although when all the hairs have the strain put upon them equally, the adhesion of their discs suffices to support the insect, yet each row may be detached separated by the gradual raising of the tarsus and pulvilli, as when we remove a piece of adhesive plaster by lifting it from the edge or corners. Flies are often found adherent to window-panes in the autumn, *their reduced strength not being sufficient to enable them to detach their tarsi.*"

Hogg also says :—"The delicacy of the structure of these hairs in the fly, the bend near this extremity, in each of which supervenes an elastic membranous expansion, and from which a very minute quantity of clear transparent fluid is emitted when the fly is actively moving, explains its capacity for clinging to polished surfaces."

And, again, who has not read Rev. J. G. Wood's *Common Objects of the Microscope*? This is what he says :—"The organ is seen under a very high power to be covered with hair-like appendages, each having a little disc at the end, and *probably secreting some glutinous fluid which enables the creature to hold on to perpendicular and smooth surfaces.* Many of my readers will doubtlessly have noticed the common fly towards the end of autumn walking stiffly upon the walls and evidently detaching each foot with great difficulty, age and infirmity having made the insect unable to lift its feet with the requisite force."—F. C. Cox.

I think the question of how the flies walk has been ventilated before in our Note-Books. In addition to the authorities quoted

by Mr. Cox, Mr. Lowne also expresses the same view—viz., that adhesion is effected by means of a viscid fluid poured out from the hairs, and states * that the foot-prints left upon glass by the house-fly consists of rows of dots corresponding to the hairs.

He describes, moreover, the sac which secretes this viscid fluid, which, he says, fills the whole of the last four tarsal joints. He has also described this sac in *Dytiscus*, but I cannot at the moment refer to it. I certainly cannot see hooks in the slide sent by Mr. Locock, but bulbous tipped hairs. A. HAMMOND.

Boring Sponges.—These were taken from an oyster-shell. The oyster has many foes to contend with, and hundreds of them are destroyed by the boring sponges, which riddle the shells with holes and then live on their victims. This was certainly the case with the oyster from which these objects were taken, for the shell was bored through and through, and when opened contained nothing but mud, the poor oyster having met with an untimely end. M. A. HENTY.

Oyster shells perforated with holes drilled by these *Clione* are often to be seen at the fishmonger's. When examined fresh, with a good pocket-lens, these shells will be seen to be coated and lined with a yellowish substance, which forms part of the *Cliona* or Boring sponge. How it excavates these holes and cavities is a mystery; but it seems to have the power of dissolving away the lime for the purpose of living on the animal matter contained in the shell. The holes are generally of two sizes—the larger for the emission of oscular tubes; the smaller, which are much more numerous, for the poriferous tubes. On splitting the shell open, both are found to communicate with irregularly sunken canals, occupied by the yellowish coloured body of the sponge.

To obtain a good collection of the spicules, boil this yellow-looking substance in dilute nitric acid, and abundance of spicules will be found. No doubt the animal uses these in its borings. If the oyster fresh from the sea be placed in a vessel of cool sea-water, delicate mobile tubes will be seen protruding from the various apertures. Those from the larger holes end in a single oscular opening; those from the smaller expand at the end into a

* Lowne's *Anatomy of the Blow-Fly*, p. 21.

conical form resembling the rose of a watering-pot, only that the margin is fringed with a corona of delicate diverging spicules. The tubes are very sensitive to *touch* and *light*. They instantly contract and withdraw themselves when exposed to powerful sunlight. Currents of water flow *into* the poriferous tubes and *out* of the oscular tubes. In autumn this sponge mass will be found crowded with ciliated embryos, about 1/20th of an inch long, with spicules already developed in them. These Cliones are also found in a fossil state in the shells of the Silurian strata, where we find Belemnites perforated by them in a similar manner to the recent oyster. Miss Henty's slide shows the spicules well with a high power.
E. E. JARRETT.

This slide is a happy variation from the usual run of slides, and Miss Jarrett's note adds greatly to the interest of it.

The process by which such soft, helpless-looking creatures as these tiny sponges are able to perforate hard shells, and even limestone rocks, is so obscure and so difficult of explanation, that some naturalists—and Dr. Bowerbank among them—have been led to deny the possibility of the thing. They hold that these borings are the work of marine annelids, and that the sponges afterwards appropriate them for purposes of protection and concealment, and live there as parasites upon the shell. But the balance of evidence seems to be in favour of the Sponges *making* the holes as well as living in them. Those who care to go into the subject will find it somewhat fully discussed in *Quekett Journal*, No. 47, July, 1881.
J. H. GREEN.

Although the question as to whether the sponge does the boring for itself is fully discussed in the number referred to of the *Quekett Journal*, the matter is not settled. I think there is much probability in the view that the sponge itself excavates the hole it occupies. How it does so is another question which Mr. Waller, the writer in the *Quekett Journal*, does not attempt to settle.
GEO. D. BROWN.

Can the boring be effected by evolution of carbonic acid from the sponge, dissolving away the carbonate of lime of the shell? Some of the lichens (*Verrucaria*) in some such manner sink their shields deeply into the limestone rock on which they grow.

Miss Jarrett must be in error about boring-sponges being found in Silurian Belemnites. The Belemnite is not a shell, but an internal skeleton, and the Belemnitidæ do not make their appearance in geological time until long after the Silurian period, beginning and ending, in fact, with the Secondary. H. F. PARSONS.

Black Background for Mounting Specimens.—While using Dr. Dudgeon's pocket Sphygmograph, I was greatly struck by the good background produced by holding enamelled paper over the flame of burning camphor until it became coated with soot.

The tracings of the needle were also very white and well defined. This led me to think that it might be applicable for opaque mounting, and peculiarly suited for mounting many species in numbered spaces on our slide. I tried it and found it to work very well. The following is the process I have found most successful:—The paper is first gummed to a slip of thin card, and after it is dry held over the flame of burning camphor until the surface is evenly coated.

I found it tedious to rule each line separately, so I hit on a plan which has proved very successful. I took a paper of pins, and after selecting an even row I gummed it to a glass slip, and fixed a handle to the other side of the slip. By this means I could rule all the parallel lines at one stroke, and by another stroke all the lines at right angles to these, thus dividing the slide into equal spaces.

The spaces can then be numbered with a mounted needle. A weak solution of shellac in spirit should then be poured over the blackened surface and allowed to dry, when it will be found quite fast. The specimens may then be stuck on in the ordinary way with gum.

The gum I use is a mixture of equal parts of gum arabic and tragacanth dissolved in cold water with a little glycerine, and the whole evaporated in a small ointment-pot and kept dry. A drop of water placed on the surface of the gum will dissolve enough for a slide in a few seconds. This combination neither breaks the specimens nor lets them get loose. S. M. MALCOMSON.

Bryozoic Rock, Clifton.—The Bryozoa—or Moss Coral, as they are called by some; Cilio-branchiate Polypes by others—are

of a higher grade than the simpler Polypes, and form a numerous class of their own. Ehrenberg and D'Orbigny have detected hundreds of microscopic fossil species, and it appears that their shells, or outer tissues, enter largely into the composition of chalk-beds, compact mountain limestone (as in Clifton), the flints of the Jara limestone, the Sea-sand of Europe, the Mauritius, the Sandwich, and other islands, and even the sand of the Libyan Desert! Some idea of their extreme minuteness may be formed when some levigated whiting is spread out mixed with water and placed under the microscope, when a Mosaic work of these animalcules of varied and beautiful forms may be seen by its means. A power of ¼-in. shows the cells in the transverse sections in the slide before us splendidly. E. E. JARRETT.

The Bryozoa or Polyzoa are, or ought to be at least, familiar to most of our members, the *Flustra*, or Sea-Mats, being an example of the marine, and *Plumatella*, etc., of the fresh water. I have tried, but without success, to see a mosaic of beautiful forms of Bryozoa, or indeed anything else in whiting. Are the Bryozoa animalcules? Perhaps this depends on what an animalcule is.

A. HAMMOND.

Batrachospermum, To Mount.—I have found no difficulty in preserving Batrachospermum in glycerine by Hautzsch's method. Hautzsch's fluid consists of a mixture of Alcohol, 3 parts; Distilled water, 2 parts; and Glycerine, 1 part. This is nearly of the same specific gravity as water. The specimen is floated in a cell filled with this fluid, and set by, lightly covered to keep out dust. The spirit and water gradually evaporate and leave the glycerine behind. In this way the water in the texture of the plant is gradually replaced by glycerine, and we avoid that shrinking from exosmosis which takes place when the specimen is suddenly transferred from water to a dense fluid like glycerine.

H. F. PARSONS.

Blood, Circulation of, To see.—Dr. C. Hüter, a German savant, has devised a simple arrangement which makes visible the circulation of the blood in the human body. His method is as follows:

The patient's head, being fixed in a frame, on which is a contrivance for supporting the microscope and a lamp, his lower lip is

drawn out and fixed upon the stage of the microscope by means of clips, the inner surface being uppermost, and having a strong light thrown upon it by a condenser. When these arrangements are completed, all the observer has to do is to bring the microscope to bear on the surface of the lip, using a low power o.g. and focussing a small superficial vessel. At once he sees the endless procession of the blood corpuscles through the minute capillaries, the colourless ones appearing like white specks dotting the red stream. Dr. Hüter asserts that by taking careful note of variations in the blood-flow and changes in the corpuscles, he has derived great advantage in the treatment of medical cases. This is the first instance of the flow of the vital fluid in one person being watched by another. T. F. UTTLEY.

Bacilli from Phthisis.—For an admirable paper on this, see our *Journal* for July and October, 1883, which is the best *resumè* of the subject I have seen. I searched the secretions in three cases of marked *phthisis* in vain—no bacilli to be seen; and then finding some in other cases, it occurred to me that the former were using antiseptic inhalations—the latter not. This does not at all imply that the antiseptic had removed all the algal life from the sputum. C. P. COOMBE.

I have examined the sputa in very many cases, and, so far, think that there is no doubt of the value of this discovery, both as a means of diagnosis and also of prognosis. In my experience the greater the abundance of the bacilli, the sooner will a fatal termination of the case occur. If they are few in number, and keep so, the patient will not become rapidly worse. J. DEANS.

Bone, Human.—Griffith's text-book, p. 114, says:—"In examining a transverse section of bone, one or several large cavities will be seen with the naked eye in the centre of the section; these contain the marrow or medulla. In the long bones the medullary cavity is single, and runs longitudinally down the bone; whilst in the flat bones the cavities are numerous, forming cancelli. Under the microscope, thin transverse sections of bone exhibit oval or rounded holes, or foramina, which are sections of canals conveying blood-vessels through the bone; these are the *Haversian canals*. Around the sections of these canals are seen numerous concentric

rays, indicating layers or lamellæ of bony matter. The substance of bone presents numerous black, somewhat elongated bodies, called *lacun* (*lacunaœ*, a little hollow), or bone corpuscles, which are, however, hollow, therefore not truly corpuscles, as they were formerly considered. Between the adjacent lacunæ run numerous fine, dark, branched lines, consisting of very minute canals, or *canaliculi*. If the section of bone be viewed by reflected light, the lacunæ and canaliculi appear white. In the dried bone they contain air.

The structure of bone is best seen when viewed as a transparent object in the dry state; for when the section is immersed in liquid, the lacunæ and canaliculi become filled up.

T. F. UTTLEY.

Bath Microscopical Society.

The Bath Waters.

AT a recent meeting of the Bath Microscopical Society, Mr. J. W. Morris, F.L.S., read an extremely interesting paper on "Hazel Nuts and their Crystallised Contents found in the course of Excavations at the Roman Baths."

Mr. MORRIS explained that the subject which he had to bring before them had come to light, if he might use such an expression, in rather an accidental way. There was nothing at all novel or strange in the fact of hazel nuts being found among the Roman remains. They had been found from time to time for centuries past, and there were a good many of them in the cases at the Pump Room. The odd thing was that through these long ages nobody ever thought of 'inquiring within upon everything,' until the results were discovered which were being placed before them. The frequent occurrence of the nuts was noted by Stukeley, who in 1724 wrote as follows:—"It is remarkable that at the cleansing of the springs, when they set down a new pump, they constantly found great quantities of hazel nuts as in many other places among subterraneous timber. These I doubt not to be the remains of the famous and universal deluge, which the Hebrew historian tells

us was in the autumn, Providence, securing by that means the revival of the vegetable world."

A sufficiently curious comment, but still nothing like so curious as the fact that with the nuts to hand and the microscope at their elbow, no one had thought of looking to see what was inside them. On one occasion, in the earlier days of the excavation, a man came up with some of the nuts in his hand, and he (Mr. Morris) had no sooner taken them up than he noticed something gleam through a crack in one of them. This brought the pocket-lens out, and then he saw that there was really something to investigate. The contents proved to be various kinds of crystals, which were not only interesting and beautiful, but were in many respects important, as bearing testimony on one or two points in connection with the Bath mineral waters. In some cases the kernel was found to have been converted into solid calcite; in others it had perished, and the shell or testa of the nut was lined with crystals. In some instances where the nuts had been cracked, water had infiltrated through the cracks. The water which came in poured with it the pulverised, smashed, and crushed atoms of broken crystals, and strewed over the projecting peaks and pinnacles of the carbonate of lime, a perfect shower as if a snowstorm had descended upon the Alps. A curious thing was that in the clefts of these peaks he had found the sporangia and the scale of a fern. Some of the nuts were filled with quartz sand just like that preserved at the Royal Baths, and on searching through this they found curious evidences of organic remains.

The microscope showed him a spray of Selaginella absolutely to be identified, while close by were a number of the spines of Echini. These must have been washed into the nut through cracks. Projecting from the sides, or lining the testa of the nuts, crystals of strontia were found, being readily recognisable by their blue tinge and their radiating fan-shaped distribution. There was also arragonite. Carbonate of lime, when mixed with a little strontia, would frequently yield arragonite, but the latter was very apt to fall from the surface on which it was formed as it had in the case of one of his best specimens that evening on the way to the Institution. They found in these crystals curious evidences of change of temperature. In many instances a change of tempera-

ture had caused the carbonate of lime to take the form of arragonite and in others the form of calcite. The strontia crystals, radiating and bundled like a closed fan, had a magnificent sheen upon them, and were remarkably beautiful.

If they took the analysis of Bath waters, they would find it stated in some of them that traces of strontia were found; in other instances, it would be said that traces of strontia were suspected. Was it not an interesting thing, therefore, that what by chemical analysis of the water was "suspected" or barely traced, they could now by this natural process show as actual crystals?

The question naturally arose how far these crystals were due to the action of the Bath waters at different temperatures on these nuts, either by coming through cracks or absolutely finding their way through the pores of the shell, and how far they might be due to the properties of the hazel nut. He was at one time half disposed to think that he must credit the hazel with some share of the performance, but he was rather disposed to give that theory up, as one day he had accidentally discovered similar crystals in the skull of a Romano-Briton at the Pump Room. Another curious feature about these hazel nuts was that the spiral fibre was found to have remained, although the nuts themselves had perished. It was sufficiently perfect for the instruction of a Botany class. The lecture also contained other points of interest, and Mr. Morris was heartily thanked for delivering it. The specimens exhibited by Mr. Morris were of great interest and beauty.

Reviews.

Practical Methods in Microscopy. By Charles H. Clark, A.M. Cr. 8vo, pp. xiv.—219. (London: Isbister and Co.) Price 6/-.

This is a very well arranged and useful book professedly for beginners, and is designed to afford the means of acquiring the necessary training. The methods described are thoroughly practical. There are many illustrations in the text, besides several plates giving very distinct photographic reproductions of 17 microscopic objects. In the appendix will be found a number of useful formulæ, staining fluids, mounting media, etc.

Essentials of Vegetable Pharmacognosy. By Henry H. Rusby, M.D., and Smith E. Jelliffe, M.D. Royal 8vo, pp. 149. (New York: D. O. Haynes and Co. 1895.)

A treatise on Structural Botany, designed especially for Pharmaceutical and Medical Students, Pharmacists and Physicians; it is divided into two parts--the first by Dr. Rusby on the Gross Structure; the second by Dr. Jelliffe on the Minute Structure of Plants. Both parts are well written, and thoroughly illustrated, there being 560 illustrations in the book.

A Text-Book of Dynamics. By William Briggs, M.A,, LL.B., F.R.A.S., etc., and G. H. Bryan, M.A. Cr. 8vo, pp. 192—xiv. (London: W. B. Clive.) Price 2/6.

In this volume of the University Tutorial Series, the use of Mathematical Formulæ has, as far as possible, been avoided in the solution of problems and worked examples. Considerable attention has been paid by the authors to "average velocity" and "relative velocity." Due prominence is also given to the metric system of units, and care is taken in all examples to point out what units are used at each stage of the process. Many worked-out examples will be found throughout the book.

Physical Laboratory Manual for Elementary Science Classes. By H. N. Chute. Cr. 8vo, pp. xvii.—218. (London: Isbister and Co. 1896.) Price 2/6.

In this work the instructions in the manipulation of apparatus are made unusually full, at the same time pointing out the difficulties which are most likely to arise. Special attention is given to the important subject of tabulating and working out results, and deriving from them their proper conclusions. There are a number of illustrations, and we feel sure the book will prove most helpful to the student.

A Laboratory Course of Experimental Physics. By W. J. Loudon, B.A., and J. C. McLennan, B.A. Large 8vo, pp. viii.—302. (London: Macmillan and Co. 1895.) Price 8/6 net.

This contains a series of elementary experiments specially adapted for students who have had but little acquaintance with higher mathematical methods. These are arranged, as far as possible, in order of difficulty. The experiments in Acoustics are simple and of such a nature that most of them can be performed by beginners in the study of Physics. Throughout the entire work simplification of method has been the great aim of the authors.

Text-Book of Elementary Biology. By H. J. Campbell, M.D. Cr. 8vo, pp. xii.—306. (London: Swan Sonnenschien & Co. 1895.) 6/-

In this (the second edition) the author treats of Protoplasm, Cells, Cell-division, Reproduction, the early stages of Development, and the massing together of Cells to form Tissues. There are also chapters on the Vertebrata, Invertebrata, and Plant Structure. A chapter on the Dog-fish is given as a type of the lower Craniata. In the Appendix will be found an account of the Spirogyra and of the Anatomy of the Earth-worm and Frog. There are 136 good illustrations in the text.

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A Contribution to our Knowledge of Seedlings. By the Rt. Hon. Sir John Lubbock, Bart., M.P., F.R.S., D.C.L., LL.D. Cr. 8vo, pp. vi.—288. (London: K. Paul, Trench, Trubner, & Co. 1896.) Price 5/-

We are pleased to be able to notice a popular edition of Sir John Lubbock's very exhaustive treatise on Seedlings, which appeared a few years ago in two large octavo volumes. In the smaller volume before us a large amount of information is given, illustrated by 282 figures in the text.

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British Moths. By J. W. Tutt, F.E.S. Cr. 8vo, pp. xii.—368. (London: Geo. Routledge & Sons. 1896.) Price 5/-

We have much pleasure in directing the attention of our friends to Mr. Tutt's new work. The author is the editor of *The Entomologists' Record.* His aim in this work is to point out to young collectors and students the present condition of entomological science, and to make them correct and accurate observers. There are 12 coloured plates and 60 engravings in the text. It will be found a most useful book.

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A Hand-Book to the Game Birds. By W. R. Ogilvie-Grant. Vol. I., Cr. 8vo, pp. xvi.—394. (London: W. H. Allen & Co. 1896.) 6/-

This volume of "Allen's Naturalist's Library" describes the Sand-Grouse, Partridges, and Pheasants, the aim of the author being to provide such a book as will be useful to the sportsman in every part of the world; and the present volume will prove of service to travellers in Africa, as it gives a diagnosis whereby every species of Francolin known up to the present time may be distinguished. Besides several engravings in the text, there are 21 nicely coloured plates.

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The Story of the Solar System, Simply Told for General Readers. By George F. Chambers, F.R.A.S. 12mo, pp. 202.

This is one of the interesting "Story" series, and a companion volume to the "Story of the Stars," published a short time ago. These little books convey a large amount of information in a most readable form. A chapter is given to each of the Planets, and one to Comets. There is also a useful Table of the Solar System, and 20 illustrations.

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The American Annual of Photography and *Photographic Times* Almanack for 1896. 8vo, pp. 370. (New York: The Scovill and Adams Co. 1896.) Price—in paper covers, 2/-; boards, 4/-

This is the tenth volume of the series, and, so far as we can judge, is the best yet issued. It contains contributions from some sixty authors and an unusually large number of plates and other illustrations; also, 150 Formulæ and Useful Recipes.

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The Medical Annual and Practitioner's Index: A Work of Reference for Medical Practitioners. Cr. 8vo, pp. 732. (Bristol: John Wright and Co. London: Simpkin, Marshall, and Co. 1896.) 7/6 nett.

This important work has now reached its fourteenth Annual Volume, and is the result of the labours of thirty-six contributors and editors, each of whom

treats of a special subject. As these subjects are so varied, it will be impossible to name them all. Suffice it to say that the Dictionaries of New Remedies and of New Treatment occupy important positions in the book, and as a proof of the up-to-date character of the work, we notice a paper on Rontgen's Method of Shadow Photography, by E. H. Fenwick, F.R.C.S., with additions by J. W. Gifford and J. L. Thomas. There are 18 plates, many of them coloured, and 72 wood engravings.

THE TUTORIAL FRENCH GRAMMAR. By Ernest Weekley, M.A., and A. J. Wyatt, M.A. Cr. 8vo, pp. viii.—216+165. (London: W. B. Clive.) Price 4/6.

This work contains in one volume *The Tutorial French Accidence* and *The Tutorial French Syntax*, the object of the authors being to give a clear and fairly complete account of French inflexions and syntactical rules, and to bring into prominence all points of fundamental importance. Special stress is laid upon idiomatic usages, in which the English and French languages essentially differ.

COMMON-SENSE EUCLID, Part I. By Rev. A. D. Capel, M.A. Crown 8vo, pp. 155. (London: Abbott, Jones, and Co.)

This is devoted to the 1st and 2nd Books of Euclid, and contains upwards of 300 graduated Riders and Hints for their Solution. In this (the fourth) edition the figures are inserted in the text.

A NEW ENGLISH DICTIONARY on Historical Principles. By Dr. James A. H. Murray, Jan., 1896. (Oxford: Clarendon Press.) 2/6.

The last part of the Oxford English Dictionary contains the words between DEVELOPMENT and DIFFLUENCY, thus finishing the words in DE and proceeds with those in DI, and includes a long series of technical and scientific terms of ancient, mediæval, and modern formation, amongst which we notice *diabetes*, *diagnosis*, *dialectic*, *diameter*, *diaphanous*, *diaphragm*, and many others.

ANALYSIS OF THE CHESS ENDING, King and Queen against King and Rook. By "Euclid." Edited and arranged by E. Freeborough. 8vo, pp. xii.—132. (Hull: 9 Parliament Street. London: K. Paul, Trench, and Co. 1895.) Price 5/-

The remarkable positions brought about in the play of Queen *v.* Rook are generally treated as if they were deficient in interest, and offered little practical difficulty. The author in this treatise has, however, demonstrated that the defence has numerous resources. Every variation from the main play has been illustrated by a diagram, and treated as a problem. The Chess Player will find much here to interest him.

THE UNRIVALLED ATLAS of Modern Geography. (Edinburgh and London: W. and A. K. Johnstone.) Price 3/6.

This well-bound and most useful Atlas contains 40 Maps and an Index of 20,000 names of places. The size of the maps is about 14½ in. by 11 in. They are distinctly printed and nicely coloured.

THE OXFORD THUMB PRAYER BOOK. (London: H. Frowde.) Contains the Book of Common Prayer and Hymns, Ancient and Modern, in perfectly distinct and readable type. The number of pages is 862, and size 2 in. by 1⅝ in. by ¾ in. We believe the price of these books varies from 3/-, according to binding, etc.

THE MITE BIBLE.

THE MIDGET TESTAMENT. (Glasgow: D. Bryce & Sons.)

These are undoubtedly the smallest Bible and the smallest Testament in the world. The Bible is a reduced facsimile of the Oxford nonpareil 16mo edition, with 28 reduced facsimile line illustrations. It contains 916 pages, size $1\frac{3}{4}$ in. by $1\frac{1}{8}$ in., and weighs 180 grains.

The Testament is a reduced facsimile of the Oxford pica 16mo New Testament. Size $\frac{3}{4}$ in. by $\frac{1}{2}$ in., and weighs only 26 grains. Both are furnished with magnifying glasses for reading. The type when magnified is very clear and distinct. The price of the Bible is 2/3, the Testament 1/3.

THE ANIMAL WORLD: A Monthly Advocate of Humanity. Vol. 26, fol. pp. 192. (London: S. W. Partridge and Co. 1895.)

This volume contains the twelve monthly parts issued by the Royal Society for the Prevention of Cruelty to Animals, and is full of interesting matter relating to various members of the animal kingdom. It contains also a large number of illustrations.

THE BAND OF MERCY, Vol. XVII. 4to, pp. 96. (London: S. W. Partridge and Co.)

Another book issued by the same Society, suitable for younger children, is also full of interesting reading matter relating to animals, birds, etc. The pictures in both books are sure to please our young friends.

THE BOOK OF THE FAIR. Parts 13, 14, 15, 16. (Chicago and San Francisco: The Bancroft Publishing Co.) Price $1 each.

"The Book of the Fair" is the only work in any wise attempting to reproduce in print the great Chicago Exhibition entire. It presents in attractive form the whole realm of art, industry, science, and learning as exhibited by the nations, so far as can be done within reasonable limits. The entire work will consist of 1000 imperial folio pages (12+16 in.), and will be completed in 25 parts.

In the parts before us the section devoted to Mines, Mining, and Metallurgy is concluded; other subjects considered are Fisheries and Pisiculture; Transportation; the Live Stock Department; and Anthropology and Ethnology.

The entire work, whether we consider the paper, print, or illustrations, is excellent, and when completed will make one of the handsomest volumes we have seen.

BEETON'S NEW DICTIONARY of Every-day Gardening, Cr. 8vo, pp. 731. (London: Ward, Lock, and Bowden. 1896.)

This is an entirely new edition, completely re-written, thoroughly revised, and considerably extended, and forms a popular cyclopædia of the theory and practice of Horticulture, Floriculture, and Pomology in all their various branches, to which also is added a Monthly Calendar of Garden Work throughout the year. It contains a large number of illustrations and many good coloured plates, each with a key giving the names of the flowers represented. It is unquestionably a valuable and most useful book.

DIE NATURLICHEN PFLANZENFAMILIEN. By A. Engler. Nos. 126, 127, 128. (London: Williams and Norgate. Leipzig: W. Engelmann.)

These parts contain the continuation of the Acanthaceæ, by G. Landau; Myoporaceæ, by R. v. Wettstein; Phrymaceæ, by J. Briquet; Plantaginaceæ, by O. Harms and C. Reiche; Verbenaceæ and Labiatæ, by J. Briquet; Sabiaceæ, by O. Warburg; Melianthaceæ, by M. Gurke; Balsaminaceæ, by O. Warburg and K. Reiche; Rhamnaceæ, by A. Weberhauer. There are 49 well engraved illustrations, giving 351 figures.

THE ROYAL NATURAL HISTORY. Edited by Richard Lydeker, B.A., F.R.S., etc. (London: F. Warne and Co.) 1/- monthly.

Has now reached its 29th monthly part. The last two parts are devoted almost exclusively to Fishes, of which there are four good coloured plates and a great number of engravings.

THE NEW PHOTOGRAPHY. By Arthur B. Chatwood. Cr. 8vo, pp. 128. (London: Downing and Co. 1896.) Price 1/-

Here we have something quite new; indeed, all the new developments in photography are practically considered. There are chapters on the X Rays, Colour Photography, Psychic Photography, Retinal Impressions, Spirit Photography, and Anaglypa. The author appears to be well up in Electricity. This is indeed a very up-to-date work, and will afford subject for much thought.

THE ABC OF MODERN (DRY-PLATE) PHOTOGRAPHY. Cr. 8vo, pp. viii.—193. (London: The Stereoscopic and Photographic Co.)

This well-known little book has reached its 24th edition, each of 5,000 copies, and gives a large amount of information, which, although specially valuable to a beginner, will be useful to a more practised hand. It is well illustrated.

BRIGHT AND SON'S ABC Descriptive Priced Catalogue of the World's Postage Stamps, Envelopes, Post-Cards, etc. Cr. 8vo, pp. xiv.—695. (Bournemouth: Bright and Son. London: Simpkin, Marshall, and Co. 1896.) Price 1/9.

Stamp collectors will find this a very convenient and useful catalogue. The stamps of each country are arranged in chronological order, according to the date of issue. There is a good money table and a reduced facsimile of all the stamps. We regret that these, in many cases, are not so distinct as we could have wished, being, as we suppose, photo-reproductions of the stamps themselves instead of from engraved blocks.

We have received from Messrs. Cassell and Co.:—

THE STORY OF THE HEAVENS.

SCIENCE FOR ALL.

BATTLES OF THE NINETEENTH CENTURY.

EUROPEAN BUTTERFLIES AND MOTHS.

CHUMS.

Some Notes on the Victoria Regia.

By Charles Hoole, assisted by W. Harrow
(Curator of Sheffield Botanical Gardens).

IN reading a few short notes on that truly royal genus of the *Nymphæaceæ*, or Water-lily family, the *Victoria Regia*, before a Sheffield audience, I thought it would not be inappropriate to quote a notice from the *Horticultural Magazine*, as that work was edited by Mr. Robert Marnock, curator of our Botanical Gardens, and published by the late Mr. G. Ridge, whose shop in King Street I well remember as a general meeting place of those interested in books and book-making (no allusion to the trade). The extract is from the March No. of 1838, and is as follows; I must ask you to bear in mind that it was written nearly sixty years ago:—"An undoubted addition to a tribe of plants, at once so beautiful and so circumscribed as that of the Nymphs or Water-lilies, would be an event of interest, even if it only related to a distinctly marked species of some well-known genus. But when the discovery is not only a new genus, but a plant of the most extraordinary beauty, fragrant, and of dimensions previously unheard of in the whole vegetable kingdom, except in the collosal family of Palms, an interest must then attach to it which can rarely be possessed by a novelty in natural history.

"Such a plant is the subject of the following notice:—A Water-lily, exhibiting a new type of structure, of the most noble aspect, of the richest colours, and so gigantic that its leaves measure above eighteen feet and its flowers nearly four feet in circumference, was met with in British Guiana, in lat. 4° 30′ N. and long. 58° W. nearly, by Mr. Robert Schomburgh, a German gentleman, travelling on account of the Royal Geographical Society, assisted by her Majesty's Government, for the purpose of examining the natural productions of that part of the British dominions. In an account of the plant transmitted to the Geographical Society, Mr. Schomburgh speaks thus of the discovery:

"It was on the 1st of January this year (1837), while contending with the difficulties Nature imposed in different forms to our progress up the river Berbice (in Brit. Guiana), that we arrived at a point where the river expanded and formed a currentless basin. Some object on the southern extremity of this basin attracted my attention. It was impossible to form any idea what it could be, and animating the crew to increase the rate of their paddling we were shortly afterwards opposite the object which had raised my curiosity—a vegetable wonder! All calamities were forgotten; I felt as a botanist, and felt myself rewarded. A gigantic leaf, from five to six feet in diameter, salver-shaped, with a broad brim, a bright green above, and a vivid crimson below, rested upon the water. Quite in character with the wonderful bay was the luxuriant flower, consisting of many hundred petals, passing, in alternate tints, from pure white to rose and pink. The smooth water was covered with the blossoms, and as I rowed from one to the other I always observed something to admire."

Some drawings were sent home by Mr. Schomburgh. He considered the plant a species of *Nymphæa*, and was desirous that it should be distinguished by the name of *The Queen*—a wish with which her Majesty has been graciously pleased to comply.

He adds that the flower is much injured by a beetle (*Trichius* sp. ?), which destroys completely the inner part of the disc. We have counted sometimes twenty to thirty in one flower. Specimens are deposited in the cabinets of the British Museum.

So much for the account in a local publication; but it is now stated that the first traveller who discovered this plant was Hænke in 1801; but M. D'Orbigny was the first to send specimens to Paris in 1828. They were, however, neglected or overlooked. In a work published some few years after this time, M. D'Orbigny mentions having discovered the plant in the river Parana in British Guiana. It was known, he says, to the natives by the name of Irupe, in allusion to the shape of the leaves, which resembles that of the broad dishes used in the country. The Spaniards called the plant Water-maize, as they collect the seeds and eat them when roasted. In 1832 a German traveller found it in some tributaries of the Amazon; but it was not until the late Sir Robert Schomburgh discovered it in the river Berbice in 1837, as you have

before heard, that public attention was drawn to the magnificent plant. The *Victoria Regia* is a very rapid grower, and in consequence of that characteristic an observer was able to note the rate of growth every five minutes, and his results show very clearly the frequency and extent of the spontaneous irregularities in the rate of growth. The observations were taken in the month of August.* From eleven in the evening until twelve midnight the lengths of growth were, roughly speaking, from rather more than a quarter of an inch to about three-eighths of an inch every five minutes, giving a total of about four inches for the hour. From twelve midnight to one a.m. the lengths were from rather more than a quarter of an inch to nearly three-quarters of an inch, giving a total of about five inches for that hour. The temperature both of water and air scarcely varied, and the plant was exposed to candle-light. The foregoing measurements refer to the petiole, or leaf stalk, *only*. I must now express my indebtedness to my friend, Mr. Harrow, the distinguished curator of our Botanic Gardens, for much valuable assistance and for the material for the slides which I have the pleasure of submitting to your inspection.

In the summer of 1893—which, you may remember, was a very bright and sunny one—Mr. Harrow was very successful in the cultivation of *Victoria Regia*, having no less than thirty-eight flowers, most of them twelve and a-half inches in diameter. A few of the later ones were rather smaller, although perfect in form and colour. The first opened on July 9th and the thirty-eighth on Nov. 26th. Thirty-eight is an exceptionally large number of flowers for the plant to bear during one season, and it is doubtful if so many will be seen again for some years. The seed of the original parent was selected a few years ago from the finest plant that could be found amongst some thousand acres of Victoria Regias. I may say that seeds two or three seasons old germinate sooner than new ones. The Victoria Regia has been in cultivation in our gardens some forty years, and only during one year has the house been without its royal occupant. There are but two other botanical gardens in England where the *Victoria Regia* can

* *Lectures on the Physiology of Plants.* By Dr. Sydney Howard Vines, F.R.S., late Fellow of Christ's College, Cambridge. Published by the Cambridge University Press.

be seen; these are the Gardens at Kew and the Botanical Gardens in Regent's Park, London. It is also grown in two or three private establishments in this country. In the past season of 1895, some exceptionally large leaves were produced, which I think may fairly claim to be called record leaves. The largest was seven feet three inches in diameter; a number of others ranged about seven feet, with upturned rims, varying from three to four and a-half inches. The fully-grown leaves can sustain considerable weight without being submerged. A chair was placed upon one of them, having previously had two thin boards put to prevent the chair-legs from bursting the leaf. Mr. Harrow and some of the gardeners sat upon the leaf in turns, and in one of the trials a weight of about eleven and a-half stones was sustained. This plant produced twenty-seven flowers. The first opened in the last week of July and the last the first week of November. The flower lasts about three days, opening in the evening and giving off a delightful perfume, which has been perceived forty or fifty yards from the house when the ventilators in the roof were open. The colour of the flower when first opened is pure white, but on opening the following evening is a deep rose and loses its fragrance. After the third day the ovary becomes gradually submerged and the seeds ripen, which takes from two to three months to accomplish, a large number being produced in an ovary.

It is on record that when Sir J. Paxton got his first bloom at Chatsworth, he was so delighted with the flowers that he chartered an express train to Eastbourne, where the Duke was staying at his marine residence, and arrived there just before the Duke's breakfast-time, and he put it on the table so as to be the first thing which would greet him in the morning. "Well done, Paxton!" was the laconic commendation of the Duke, and the great gardener went back to Chatsworth highly pleased.

The plant, as you are now aware, is, under cultivation, treated as an annual, a fresh one being raised every year. The seed is black and about the size of a pea. It is sown in the early part of January, when it is put into a tank heated with hot-water pipes, when a temperature of about 85° to 90° F. is maintained in order to germinate the seed. The young plant is potted on until April. It will then have three or four *flat* leaves about twelve inches in

diameter, and is placed in about six tons of prepared soil in the basin of the tank, which is about eight feet by two feet six inches deep. The tank itself is about twenty-eight feet in diameter, containing water kept at a temperature as near 85° as possible. The plant soon becomes established, covering the surface of the water with its handsome leaves. As a rule, only one flower expands at a time. The first leaf produced is very remarkable, including the stalk, which is scarcely distinguishable from it, is about two inches long and devoid of spines; the second rather longer, and in it the leaf and stalk are differentiated, and two or three spines appear on the stalk; the third is somewhat larger and rather similar in shape, with more spines on the stalk; the fourth assumes an oval form with pointed ends, the one over the stalk with a deep notch in it; spines begin to develop on the chief nerve. The colour underneath is of a reddish hue, and the upper surface is marked with chocolate-coloured blotches. The stalk lengthens and is covered with small spines. These spines have spiral vessels and a small cavity in their interior, opening by a little pore at the top. From the under surface of the base of the leaf-stalks numerous adventitious roots are given out. The leaf-stalks, flower-stalks, and nerves are traversed by numerous air-channels, which make the enormous leaves so well adapted to float on the water, when we remember the size and number of the veins. In the leaves of submerged water-plants, however, the strands are insignificant and many are even destitute of vessels, which is easily understood, as the need of resisting pressure and bending in submerged leaves is very slight. In most flat membranous leaves, which have one side directed towards the sky and one towards the earth, stomata are entirely wanting on the upper surface, being restricted to the under side. An exception to this is afforded by the leaves of the *Victoria Regia* and some others, they being covered with stomata on the upper side, while on the lower side, which is in contact with the water, stomata are entirely absent. It may be observed that the water-lilies have small stomata, and land ones, which belong to another order *(Liliaceæ)*, have large ones. The whole of the upper surface can receive the rays of the sun, and is thus warmed and illuminated throughout. The under-

side of the leaf is coloured violet by a pigment called *anthocyanin*, which is believed to change light into heat, and thereby materially help to warm the leaf. The leaf is pierced with numerous pores, which allow the rain or other water which may accumulate upon them to pass through, and thus prevent the leaf from being submerged. The leaves are only armed with prickles on the under surface and on the turned-up margin—*i.e.*, only where they are exposed to the attacks of plant-eating aquatic animals.

It is an interesting fact that many woody plants are only protected while young—*i.e.*, while they are short, and their foliage can be reached by ruminants, such as goats, sheep, and oxen ; but on the branches beyond the reach of the mouths of these animals no prickles and spines are developed.

I cannot close this paper without a word on a remarkable companion which the *Victoria Regia* had in the year 1893, and I will add a note which Mr. Harrow has kindly written on that curious organism, the Fresh-water Medusa, *Limnocodium Sowerbii*. It is as follows :—

Fresh-water Medusa, Limnocodium Sowerbii.

By William Harrow.

The Fresh-water Medusa which appeared in the *Victoria Regia* tank during the summer of 1893 has proved a most interesting topic to zoologists and many others, and information relating to it has been widely circulated throughout the country by various articles in the newspapers.

Professor E. Ray Lankester, in a most interesting article in *Nature*, says :—" For three years nothing has been seen of the Fresh-water Medusa in the Regent's Park, and naturalists had given up hope of carrying on any further investigation into its life-history. It seemed as though this beautiful little organism—brought, we know not how or whence, into the midst of London—had, like some mysterious comet, unexpectedly burst on the zoological world and as unexpectedly disappeared.

" I was, therefore, greatly astonished to hear in September from my friend, the Director of Kew, that the curator of the Sheffield Botanic Gardens had discovered it in a quantity in the *Victoria Regia* tank under his care during the present summer, and I was

soon after delighted by the safe arrival from Sheffield of a bottle containing living, well-grown specimens of the familiar jelly-fish."

The Fresh-water Medusa was first discovered in the Victoria Regia tank of the Botanic Gardens, Regent's Park, London, in 1880, and had never been found elsewhere until last year, when it was observed in numbers swimming about the Victoria Regia tank in these Gardens. The question at once arose, How came it to Sheffield? Professor Lankester, in the article alluded to, says :—

"The question as to how the jelly-fish got to Sheffield is easily answered. Water plants (*Nymphæaceæ* and *Pontederia*) were sent from Regent's Park to Sheffield, to re-stock the tank there, on April 4th, 1892, and on April 7th, 1893. Hence there was the possibility of some of whatever germs of *Limnocodium* existed in Regent's Park being transferred to Sheffield. The curious thing is that in 1892 and 1891 no *Limnocodium* was seen in the original source—viz., the Regent's Park tank, nor in 1893, excepting a few sent from Sheffield and placed in that tank by Mr. Sowerby.

This is the first instance recorded in which another *Victoria Regia* has been "infected" with *Limnocodium* from the original Regent's Park tank, excepting when the new tank in Regent's Park was in 1890 infected from the old one, by the transference to it of weeds and roots containing the germ of the jelly-fish.

To those unacquainted with this little creature the following description may be interesting :—"The general form of the animal resembles a small, shallow, nearly hemispherical bell, of the most delicate structure, transparent almost as glass, the tentacles of a beautiful opalescent white, and as seen floating in the water resembles the ordinary jelly-fish, but from which, however, it differs in many particulars; one of the peculiar features being that the tentacles are extended upwards, when the animal is floating, instead of hanging from the bell, as in most other members of the group. The size varies much according to age. Individuals have been noticed as small as pins' heads, one-thirtieth of an inch, and from this size ranges up to one-third of an inch, or of full-grown adult specimens, fully expanded, to half-an-inch in diameter.

The bell or umbrella is quite transparent. The marginal ring bears three sets of tentacles. The first, a set of four large, primary tentacles; the second, a tier of twenty-eight or more, secondary

medium size; and the third, a tier of one hundred and ninety or more, small, tertiary tentacles, placed in groups of six between the secondary ones. The stomach is long and tubular, extending below the disc, and may be likened to the stick of an umbrella. The mode of progression through the water is by the sudden contraction of the marginal ring, exactly like the rapid closing and opening of an umbrella or parasol, and the individual appears capable of directing its movements in whatever direction it pleases."

These jelly-fish have been sent to various places, with the view of establishing it in other quarters, though we are afraid the deed will be futile, as they have never been known to reproduce themselves. Professor Lankester, in a letter to the writer, states that the jelly-fish are produced by a little polyp, which multiplies and creeps on the rootlets of *Nymphæaceæ* and *Pontederia.* At certain times the polyp nip off a round piece from their free extremity, which becomes a jelly-fish and grows and enlarges to the adult size whilst floating in the water.

The Rontgen Rays and Precious Stones.—The observations made by Bugust and Gascard on the possibility of distinguishing diamonds and jets from many of their imitations by the application of the x rays have caused them to make further experiments. The transparency of aluminium to the rays has since led them to study the effects produced in the case of precious stones, of which that metal is a constituent. They find that the crystalline forms of alumina known as corundum, ruby, sapphire, emerald, topaz, and cat's-eye, may be classed between their imitations and the diamond with regard to the effect produced. The torquoise, which consists of aluminium phosphate, is also clearly distinguished from its substitutes by means of the rays, and mallite is almost as transparent as carbon. Fine pearls of small size are less opaque to the rays than false ones of the same size, and may be clearly distinguished from them; but in the case of larger specimens the result is less certain, depending greatly upon the manner in which the false pearls have been made.—*Pharm. Journ.*

Observations on the Structure of Cystopus Candidus.*

IN the following paper a short account is given of the structure of the vegetative and reproductive organs of *Cystopus candidus*, a fungus parasitic on cruciferous plants, and especially abundant on the common Shepherd's-purse (*Capsella bursa-pastoris*), on which it forms shining white patches, often of considerable extent, on the stems, leaves, and fruits.

The mycelium consists of non-septate hyphæ, which ramify in all directions between the cells of the host plant, and often produce extensive hypertrophy of the organ attacked. Here and there small spherical haustoria are developed on the hyphæ, and these penetrate directly into the cell cavities. Both hyphæ and haustoria contain a granular protoplasm, in which numerous nuclei can be seen. The structure of these nuclei can be made out by careful staining and examination under a sufficiently high power, as was shown by Fisch. Each nucleus is vesicular, and contains a large nucleolus, which stains deeply, and is surrounded by a less deeply stained substance, in which some indications of a granular or thread-like structure may at times be observed.

The reproductive organs are of two kinds, asexual and sexual. The asexual organs are formed just beneath the epidermis of the host-plant; they are club-shaped branches of the mycelium, from which zoosporangia are cut off by constriction and formation of a double wall at the apex. These branches contain granular protoplasm derived from the mycelium, and numerous vacuoles. A few nuclei are found scattered in the protoplasm, the number being variable, from five to twelve. The structure of the nucleus is similar to that in the mycelium, but is more easily made evident.

In the formation of the sporangium a part of the protoplasm accumulates at the apex, together with a few nuclei, four or five, or perhaps more; this is then separated from the club-shaped branch by constriction of the cell-membrane. A double cell-wall is then formed which completely cuts off the sporangium from the

* Extracted from a paper by Harold T. Wager in the *Report of the British Association*, by G. H. Bryan.

branch on which it is formed. The sporangium is thus, from the beginning, a multi-nucleated cell. Each nucleus at a later stage becomes the nucleus of a zoospore without undergoing further division. The nuclei found in the club-shaped branches are probably derived directly from the mycelium, no division-stages having been observed in the sporangiophore itself. It is possible, however, that owing to the smallness of the nuclei the division-stages are masked.

The sexual organs, antheridia and oogonia, also contain numerous nuclei. According to Fisch, the oogonium contains from ten to twenty nuclei, the antheridium three or four. More than this have been found in many cases. In the formation of the oosphere, the protoplasm separates into periplasm and gonoplasm, a cell-wall appears round the gonoplasm. A large number of nuclei remain in the periplasm, but the gonoplasm does not appear to possess nuclei at this stage; at a later stage, however, during the formation of the exospore, a number of nuclei make their appearance in the oospore around a central oil-globule. These observations do not agree with those of Fisch. According to that observer, all the nuclei of the oogonium fuse together to form the nucleus of the oosphere. According to Dangeard, the central nucleus of Fisch is nothing more than an oil-globule, and, so far as my observations go, I agree with him. Soon after the separation of the oosphere a quantity of oil begins to accumulate in or near the centre. This is stained deeply by hæmatoxylin or picro-nigrosin, and might easily be taken for a nucleus. Its oily nature may be determined, according to Dangeard, by soaking the sections for some time in chloroform, when it disappears, and a vacuole is left. The oil-globule gradually increases in size, until the exosporium is fully formed. It then takes up about one-third of the diameter of the cavity of the oospore.

The disappearance of the nuclei of the oosphere during the earlier stages of its development, is probably only apparent, some change taking place, of the nature of which we are not yet cognisant. It is probable that these nuclei are included in the oosphere at the time of its separation from the gonoplasm.

The problem of fertilisation is an important one, but is difficult to settle. At an early stage the antheridium contains numerous

nuclei, which pass over, at a later stage, into the fertilising tube of the antheridium, but whether they pass into the oospore is a question which has not yet been settled.

[An interesting, illustrated account of "Cystopus, or White Rust," was given in the *Journal of Microscopy and Natural Science* for June, 1885.—G. H. Bryan.]

The Pygidium of the Common Flea.*

By Dr. Alfred C. Stokes.

THIS organ has been studied so frequently, and by so many microscopists ; it has been used for so many years as a test of certain qualities in objectives, that further notes on the subject might be deemed superfluous; it might well be thought that the last word must have been spoken about a matter so common, not to say so hackneyed. It is because the pygidium has been so frequently examined that I cannot divest myself of the belief that the structural features which I have recently observed must have been repeatedly seen by microscopists, although these morphological points seem to be actually undescribed. I can find no reference to them in the literature of the subject which I have been able to examine, yet they are so prominent and so conspicuous that it is difficult to imagine how they could have been so long overlooked, if they have been, especially after such accomplished microscopical observers as Van Heurck, Dallinger, Nelson, Carpenter, have used the pygidium as a test. But some of these investigators, notably Dallinger and Nelson, have lately described previously unobserved features, or features which have previously been misinterpreted.

Mr. E. M. Nelson was the first to describe correctly the form of the so-called spines or hairs which clothe the inter-areolar surface, calling them lambent, meaning that they are flame-shaped, thus using the word out of its proper signification, for "lambent" means, not flame-shaped, as the eminent British microscopist

* From *The Journal of the New York Micro. Soc.*

intends to suggest, but something quite different. Other observers had noted these spines, and indeed had figured them as stout, tapering bodies arising from a circumvallate depression, to the base of which each was said to be attached by a socket-joint. The fact is that no such socket-joint, nor any structure resembling it, is present on the inter-areolar surface of the pygidium. "As an example of erroneous interpretations," says Dallinger in his edition of "Carpenter," "the representation of the pygidium of a flea by some leading sources of information of a few years ago may be instanced. It was a special test of many authors, and has been carefully figured; this shows that it was not an accidental error, which it might have been if it were merely an ordinary object; it is an error depending in all probability on a faulty system of illumination. Moreover, the error cannot be attributed to the object-glasses of the time, as it is a low-power object, and the low powers of that day were quite as good as those lately in use. In the descriptions and in the drawings, often beautifully executed, the hairs proceeding from the centre of the wheel-like discs are represented as being 'stiff and longish bristles,' thick at one end and tapering off to a point. And the small hairs round (*sic*) are described as 'minute spines'; in the drawing they are like the spinous hairs of an insect, and have the usual socket-joint at the base. In reality, the 'stiff and longish bristle' is an extremely long and delicate filament, totally unlike a bristle, being not tapered but of nearly uniform thickness. The 'minute spines' are in reality very curious hairs, and, as far as we at present know, unlike any others. They are delicate, lambent, bulbous hairs."

These "stiff and longish bristles," which issue from the areolæ, appear to be fragile, and are, as a consequence, readily broken, when they are observable on the preparation as stout, truncated filaments, usually with no trace of decreasing diameter. But when they are unbroken they certainly do taper, and do so conspicuously, at least with the specimens which I have seen. If a true bristle must taper, then are these true bristles.

The flame-shaped hairs are narrowed with a regular gradation from the somewhat bulbous base to the usually curved and acuminate tip. But if the classical socket-joint of these inter-areolar

hairs can be proved to be an error of observation, as can be easily done, then it is not unlikely that there are other structural points about the organ which may have been overlooked or misinterpreted. In fact, there seem to be several.

Of some of those to be mentioned here there is absolutely no doubt; of a single one there must be doubtful acceptance until the microtome can be brought to bear on the pygidium, when the problem may be readily solved. I have not even the skill of a novice in the use of the microtome, and those of my friends and correspondents who have attempted to section the pygidium have failed, either on account of the horny character of the subject, or because of the lack of sufficient material. When sectioned it will not be what Dr. Dallinger calls a low-power object; even in its totality it is far from being that.

The areolæ, or those superficially wheel-like bodies which, in number from thirty-two to thirty-eight (Van Heurck), constitute the double, somewhat reniform organ called the pygidium, are not the simple bodies which they are usually supposed to be. The ordinary statement of the books is, as Dr. Van Heurck puts it in the fourth edition of his work on *The Microscope*, that, "The pygidium of the flea is composed of two lobes and exhibits from thirty-two to thirty-eight long, stiff hairs implanted in the centre of each of the areolæ, each one being surrounded by a row of little cuneiform elevations. The inter-areolar spaces are covered with small spines. A good objective should show these areolæ clearly defined in all their parts, and the elevations should appear cuneiform, and not round as they are figured by Dujardin." This is not all of the structure as I see it with the best objectives of Reichert, Zeiss, and of Spencer.

Each areola is in reality a follicular depression, varying in dimensions to a degree perceptible even without the use of the micrometer, but averaging, perhaps, about 1/3000 inch in depth; and each contains, not only the long central, bristle-like filament and the cuneiform projections, which are said to form a single row, but a somewhat complex, strongly chitinous system of rods and wedges and membranes, the whole apparatus being covered by an elevated, membranous dome about as high above the general surface as the follicle is deep below it, and with a central eye

through which the long bristle projects, the dome itself bearing some minute external appendages. The areolæ are by no means the simple, uncomplicated objects they are commonly described and figured to be. They have been looked upon by microscopists as low-power objects, as Dr. Dallinger describes them, but they will prove themselves worthy of study with the highest-power objectives at our disposal. The structure of these wonderful bodies, as I see it, is shown in the accompanying diagram, Fig. 17 :—

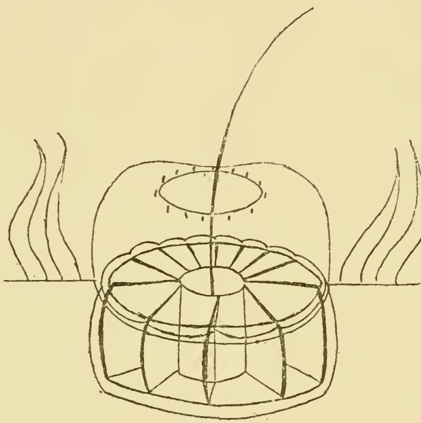


Fig. 17.
Diagram of an areola from the Pygidium of a Flea.

The walls of each follicle are vertically fluted at regular intervals, and the upper margin is, as a result, broadly crenated. The cuneiform projections (they are not elevations as commonly described) converge towards the centre from a comparatively wide band of encircling chitin, and each is outwardly continued toward the bottom of the follicle by a curved, rod-like body, which at the base becomes continuous with a second set of wedge-shaped projections, often less strongly chitinous than the upper row, and always rather shorter. There is not a single row of these cuneiform projections which have so long been used as a test for definition, and which Dr. Van Heurck says Dujardin figures as being round. There are two rows entirely distinct from each other, but connected exteriorly by the vertical rods referred to,

and shown in the diagram. At the outer surface of these vertical rods, that is, between them and the internal wall of the follicle, is a delicate membrane which constitutes the outer boundary of the complicated apparatus, and is continuous with the membrane which forms both the upper and the lower surfaces, and fills the spaces between the wedge-shaped projections. This produces a circular chamber strengthened outwardly by the vertical rods, and above and below by the cuneiform projections. If there were nothing more to the intra-follicular apparatus this chamber would be a simple, circular passage open at the centre, through which the long bristle passes. But the circular region is not open toward the centre; it is there closed by a slightly inclined membrane, which extends from the tips of the upper wedges obliquely outward to the tips of the shorter lower projections. This membrane closes the circular chamber, and produces a more or less conical space at the centre of the follicle, through which the long filament issues. But whether or not it completes the structure of this part is doubtful. I think it does not. But to become positively assured as to that, a study of sections is necessary, and here the expert microtomist will find a subject worthy of his steel. And here, too, he will meet with an object that will tax his skill in the illumination of the microscope, and his ability to manipulate the best high-power objectives. For this is not a low-power object.

But while I am unable to prove to others that my opinion is correct, still that opinion is that this circular chamber is divided, by vertical membranes, into as many cells or compartments as there are wedge-shaped projections in each row, a membrane extending from a cuneiform body above to the one directly below. I am making no positive statement about this minute structure, and it is minute enough to be a delightful task for the lover of the delectable instrument; I am expressing only an unproved opinion, leaving to the microtomist the pleasure of deciding the question, and, I am free to confess, envying him the skill needed in the delightful work. However, if these vertical membranes exist, and judging from certain optical appearances I think they do exist, then is the pygidium of the despised parasite one of the most remarkable studies with which the microscopist can become acquainted.

But perhaps the most pleasing structure, which is also one of those surprising things in Nature, is the delicate dome which arches above each follicle with its enclosed apparatus, and through whose central eye the long tapering filament projects. If this domoid membrane has not previously been observed, I am at a loss to account for the oversight. It is almost conspicuous; it demands only a slightly upward focus to define its rotundity and its circular eye; if the long bristle is followed from tip to base, the dome can scarcely fail to make itself seen.

This over-arching membrane is set down above the follicle, and is a little greater than it in diameter, the greatest width of the dome being about 1/1,800 inch, with about 1/2,000 inch to that of the depression which it covers. In the diagram it is shown as it appears in surface view, with a regularly spherical outline, the summit somewhat flattened and the region about the central eye conspicuously depressed. In some specimens, probably in all, when seen in profile, the dome is widened above, and the convex walls slope inward to the base. But as to the existence of the domoid membrane there is not the slightest doubt. It is present above every pygidial areola, adding much to the interest of the organ, somewhat to its complexity, and happily adding emphasis to the general belief that the pygidium is an auditory organ. The function of this membranous dome can be readily inferred.

It possesses, however, some minute appendages whose function is not so easily conjectured. Around the eye of the dome, as shown in the diagram, is a single row of from eight to ten projections which, for want of a better name, may be called setæ. These are positively not the tips of the flame-shaped hairs, and they are as positively not minute folds in the membrane of the dome, but strictly independent organs, minute enough to satisfy the most exacting microscopist who likes to work with high powers. In *estimated* length they vary from 1/15,000 to 1/20,000 inch. I have no micrometer ruled fine enough to measure such setæ, but the estimate seems to be at least within the actuality.

These small objects arise from the surface of the dome in a regular row, and take varying positions, being sometimes perpendicular at the edge of the eye, at times leaning over the margin; in other instances they appear further down the slope, standing

upright or variously inclined or curved. They convey the idea of solidity and of firmness, having nothing of the aspect of a bristle, for they seem not to taper, but to be minute cylinders, each apparently arising abruptly from its base, and having a truncated summit. These appearances, however, may be illusory, as the setæ are so exceedingly minute that it is difficult to decide positively. But as a test for definition, the reader will find the little appendages entirely satisfactory. He may perhaps think that the resolving power of the objective should likewise not be slight, and I should be disposed to agree with him.

All this structure, which the reader must admit to be sufficiently complex, is visible within and above the pygidial areolæ of all the common species of *Pulex* which I have examined, but it seems to be rather larger and more conspicuous within those of *Pulex irritans*, especially with those specimens which are to be had in California, where, in addition to big trees and some other large things, our microscopical friends are so fortunate as to have big fleas.

THE SPIDER PLANT.—Travellers who visited or passed the Cape Negro country of Africa, says the *Morning*, often heard from the natives of a plant that was part spider and threw its legs about in continual struggles to escape. It was the good fortune of Dr. Welwitsch to discover the origin of the legend. Strolling along through a wind-swept table-land country, he came across a plant that rested low on the ground, but had two enormous leaves that blew and twisted about in the wind like serpents ; in fact, it looked, as the natives had said, like a gigantic spider. Its stem was four feet across and but one foot high. It had but two leaves in reality. They were six feet to eight feet long, and split up by the wind so that they resembled ribbons. This is probably the most extraordinary tree known. It grows for nearly, if not quite a century, but never upwards beyond about a foot, simply slowly expanding until it reaches the diameter given, looking in its adult state like a singular stool on the plain from ten feet to eighteen feet in circumference. When the wind came rushing in from the sea, lifting the curious ribbon-like leaves and tossing them about, it almost seemed to the discoverer that the strange plant had suddenly become imbued with life and was struggling to escape.—*Journal of Horticulture.*

Time, Space, and Invisible Worlds.

By W. D. Barbour.

Part I.—TIME AND SPACE.

THE twin mysteries of time and space may well be regarded as modern discoveries. Primeval man interpreted them by the immediate things of sense. The stars were brilliant gems, and the planets wandering stars. Sun and Moon were gods, because of material benefits conferred. Space was limited by sight, and time by lunations, seasons, and history. The Infinites were there just as now, but imagination was feeble, and conceptive power wanting. Yet knowledge increased, the mind grew, the horizon dilated, and by slow degrees greater distances in space, and longer ages in time, were brought within the compass of thought. In the light of limitations such as these, our interpretations of old or primitive writings necessarily require considerable modification. Unfortunately, the same phraseology which expressed the ancient limited conception of the infinite in time and space, expresses also ours. The words are the same, but the applied meanings are incomparably different. Slowly, even reluctantly, have translators, students, and commentators, allowed for the absence of that knowledge and mental development which the present age so amply enjoys. Thus the phrases "everlasting," "without end," "for ever and ever," "eternal," "evermore," "immortal," "beginning and end," "all the earth," "the whole earth," "under the whole heaven," "the heavens," etc., embody meanings indefinitely larger to us, as compared with those understood by our forefathers, five hundred, to say nothing of five thousand years ago. Reason suggests that such phrases, however susceptible, more or less, of infinite meanings, were not spoken, or written, "over the heads" of the people to whom they were addressed, but were rather directed to the level of their limited comprehensions. Such considerations should not be overlooked in our study of the Biblical stories, alike of "Creation," and of other natural phenomena.

Just as the revelations of Geology burst the shackles of the human imagination, which, until the present century, shut up all

terrestrial time within the insignificant limit of six thousand years, so have discoveries in Astronomy overleaped those boundaries of space arbitrarily imposed by appearances and ignorance, which in present as well as in former ages have sought to make Earth the centre of the Universe, and to cabin and confine all Creation within the microscopic limits of a few thousand miles. With the advent of the telescope in 1609, when planetary discs, revolving satellites, and sphericity of Sun and Moon were first demonstrated to human sense by Galileo, there gradually dawned upon thinking minds the conviction that other globes and other worlds might exist, in which life in its thousand forms, such as we here see around us, might exist and flourish; and in which beings like ourselves, enjoying the liberty which accompanies responsibility, are working out their own destinies. The wide welcome everywhere and at all times accorded to this suggestion of life in other Planets, and in which we recognise the ever-enlarging social instinct of humanity, strongly suggests its naturalness, and therefore to some extent its likelihood. We are thus led to indulge the thought, and to anticipate the possibility, however seemingly remote or improbable, of communicating with kindred minds and hearts, upon one or other of those Planets which adorn our midnight skies. Proctor believed that it is in this aspect that astronomy acquires what powerful hold it possesses upon the popular mind.

During the five thousand years in which Astronomers were pondering and questioning in vain the distance and constitution of the Stars, and when at length their powers of belief were strained, as the piling up went on of the big distance figures, the Astronomical mind was unconsciously all this time being inducted into one of the mysteries of the Infinite. Compelled by the logic of exact measurements, the Astronomer rose to the occasion, and strove to grasp the pregnant truth that our Sun, vast in bulk (860,000 miles diamater) as he is, is yet, with all its planetary and other attendants, utterly lost, and sinks into insignificance, amid that mighty host of Suns and Systems which micrometer and spectroscope reveal as in swift and ceaseless motion through the vast abysses of space. Human sight, thus multiplied by the telescope a thousandfold, transporting us instantaneously into recesses of space, so remote that light from thence requires four

thousand years to reach us, must needs intensify our conceptions of the Universe, and prepare our minds for the bewildering truth that within that radius, on every side of this our infinitesimal globe, Planets large and small, millions in number, are now evolving like our Jupiter, Saturn, Uranus, and Neptune, or are already evolved like our Mercury, Venus, Mars, or Earth. As man cannot prescribe limits to Creation, neither should there be pause or limit to his mental efforts to grasp ever more and more of the illimitable. Whilst Professor Cleland contends that evolution of the human body has already reached its climax (as shown in the front curving in of cranium and brain, forming an arch of about one hundred and eighty degrees, of irregular cylindrical shape, commencing at point of communication of skull with spinal canal round to point above the nose, the extremes being thus nearly parallel), and that "the pinnacle of matter" is now reached, and the great object of its creation now attained, in the evolution of mind; so in the present outgoings of thought and aspiration towards the Infinite, we see one of the signs that mind, in its loftier branches, has already outgrown the physical capacities of its tenement, and is now preparing to commence a new and higher course of evolution.

In the question of evolution of Suns and worlds, it is natural that much emphasis should be laid upon analogy. Analogies and probabilites may be regarded as instances, examples, or side-lights of that which is described as the great law of Continuity, and which we may look upon as the final expression of the oneness and harmony of all Nature. Drummond has defined the law of Continuity by picturing a world without it, that is, one in which law and order are not continuous, and therefore, in which dis-continuity exists. In such a world, cause and effect would cease; no dependence could be placed upon anybody or anything, everything happening by accident or chance. Sun might rise one day in the north and set in the east; another day at midnight, or not at all. Moon might appear full when it ought to be crescent, or rising when it ought to be setting. Jupiter might appear horned, and Venus with rings and satellites. The Stars, no longer "fixed," might wander hither and thither, carrying confusion inextricable into all the Cardinal points and signs. Some years might be all summer and others all winter. The laws of light and gravitation

might change at any hour. Thus, the natural order of everything might at any moment be reversed, Earth become mad, and its inhabitants lunatics. Only thus, by extreme contrast, can we properly estimate the immense value and importance to us, of this law of Continuity throughout the Universe. Man finds in this Continuity his promise and warrant, that, "if he depend upon nature, his intellect shall not be insulted, nor his confidence abused;" and "if man has to trust nature, that his reason shall not be put to confusion." Continuity, it has been well said, "is the expression of the Divine veracity in nature."

Assuming, then, a universal oneness in nature, we should expect to find, as discovery progresses, a general harmony between truth known and truth not known; and that the great lines of natural laws, which prevail throughout, and (if we may speak of law as a governing agent) regulate our Solar System, are not only similar to, but identical with, those which exist throughout the Stellar Universe; and which we may liken to those artificial lines of longitude and latitude by which we explain the positions and movements, equally of near planets and distant stars. Following Newton's discovery in 1686, of gravitation, the greatest generalisation the world has yet seen, Sir Wm. Herschel startled the scientific world in 1802, with the announcement that amongst the Stars, binary systems exist, in which the smaller star revolves in circular or elliptical orbit round the larger. There was no mistaking the meaning of this discovery. Here was ocular demonstration of Continuity—viz.: that the same law which causes the apple to fall to the ground, which retains the Moon in her orbit, and restrains our Earth from its otherwise headlong flight away from the Sun, also controls and regulates those giant orbs in remote space.

Up to recent years, Astronomers had assumed certain truths about the Stars, but were without demonstrable evidence on the following points:—1. Constitution of the Stars. 2. Are they incandescent, and from what does their light proceed? Are any Stars motionless in space; or, in other words, do exceptions exist in outer space, to that law of Motion in matter, which appears to obtain throughout the Universe? In putting these questions to spectrum analysis, an opportunity now offered of proving or disproving, the continuity, throughout the Universe, of Solar or

Planetary matter ; also the laws to which we know matter to be subject. The answers which came were definite and complete so far as they went. 1. The Stars are found, as well as the faintness of their light enables spectroscopists to judge, to be at least partially composed of matter which is identical with that in our Sun and Earth. 2. The Stars are incandescent, and their light, so far as ascertained, is also identical with that of our Sun, varying only according to the prominence of any elements at any moment in the Star's atmosphere. 3. All Stars, bright enough to respond, are found, if not by telescope and micrometer, yet by spectrum analysis, to be swiftly in motion, and to be, just as in the case of our Sun, all coursing on their mighty journeys, at tremendous speeds, varying from 20,000 to more than 200,000 miles per hour, through the fathomless depths of infinite space ; but whither bound, whether on some vast orbit of trackless extent, or in simple obedience to the universal gravitation of all matter, no human being can tell. Here we have another great generalisation, than which there can hardly be a more conclusive testimony to that ubiquitous and all-embracing law of Continuity.

In considering the question of invisible worlds, it is necessary to remember that our Sun is not only a binary but a multiple Star, that is, a giant centre of lesser stars or planets, which, owing to the gradual cooling they have undergone during some millions of years past, have so contracted in bulk and diminished in brightness that out of the eight primary planets, four—viz., Mercury, Venus, Earth, and Mars—have become solid and dark bodies ; and the other four—viz., Jupiter, Saturn, Uranus, and Neptune, although shining partly by their own light, would yet be utterly invisible in even the great Lick telescope, if looked for from the distance of the nearest Star. Even our sun itself, glorious and majestic as he is, would at that distance sink into a Star scarcely brighter than Alcyone in the Pleiades. Could we plant ourselves upon one of the globes doubtless revolving round the southern star Phi in Ophiucus, our Sun would appear from thence as a tiny companion to Aldebaran, half-way towards the little optical double on its right, and quite possibly the aid of a telescope might be necessary to make it visible at all. In the light of considerations like these, it would appear to be more than probable that, excluding

nebulous stars and clusters, nearly every naked-eye Star, however lonely and isolated it may appear, as well as many telescopic Stars, are the majestic centres, like our Sun, of extensive systems of planets, satellites, comets, and meteor systems. We must not suppose, however, that they are all built upon the same pattern, or that all have arrived at the same degree of development as our Solar System; but until Analogy, Probability, and Continuity, have been proved to be false lights to the human mind in its search after truth, we must conclude that these globes, while differing in size, gravitation, brightness, distance, and motion, and yet resembling each other in general structure and design, all point with significant force to a oneness in origin, a oneness in purpose, and a oneness in destiny.

Part II.—INVISIBLE WORLDS IN OUTER SPACE.

By W. D. Barbour.

THE revelations of physiology under the microscope bring us near to the threshold of the mystery of Creation. We tread upon wonderful, if not holy, ground. Nature's secret processes are here unveiled to human gaze. The Divine methods are made visible. Within that unicellular speck of animal bioplasm, there lie, as Huxley tells us, "strange possibilities." "In its warm, watery cradle, rapid changes proceed, yet all steady and purpose-like, as if in the hands of a skilled modeller. As with an invisible trowel, the plasma is divided and sub-divided until reduced to an aggregation of the finest granules. Then, as by a delicate finger, the spinal column is traced, and head, limbs, and tail, become moulded in such fashion that one involuntarily imagines the hidden artist behind it all, working with his plan before him." And our wonder rises as we read in that jelly-looking speck an amazing history of mystery. Tracing its ancestry back, in thought, through countless generations and vast periods of time, which seem like eternity, we are confronted at last by our dark cloud-covered Earth, just cooling down from its primitive sun-like condition. There, in that first bioplasmic "substance, made in secret and curiously wrought," as it slowly evolves in those warm, saline, nascent

waters, we read, shall we say, the earliest conditions and environment of organic life, the hidden dawn of mind, its first contact with Terrestrial matter, and lastly, the first stage in that great drama of Creation, as revealed in those significant words, "Darkness was upon the face of the deep, and the spirit of God was brooding upon the face of the waters."

Noticeable among the characteristics of life, when once it became established upon Earth, are its immense variety, fecundity, persistency, and universality. Tyndall speaks of indurated germs which hours of boiling do not kill. Drummond reminds us of "the almost incalculable fecundity of the first created forms of life," and again of a "cloud of progeny of uncountable millions of spores; also of common births of a million each, and a motherhood in twelve days of sixteen millions of young." Philosophy has been asking for a thousand years,—"What is the meaning of all things?" Revelation long ago solved the mystery in one word,—"Life." Geology out of its rocky depths of fossilised organisms likewise answers—"Life." Mountain, lake, plain, river, forest, desert, ocean, and the air we breathe, each and all respond with, because full of—"Life." In arctic cold, as well as torrid heat, we have the same repeated story of—"Life." And the Stars in distant space are now, in their gentle light, sending us intimations of kinship with Earth and Sun; in all of which we read a like end and destiny—the Continuity of Life.

Analogical reasoning has largely forced the conclusion among astronomers that our Solar system at one time existed as a gigantic nebula, similar in appearance, and probably in nature, to those which the telescope descries as bordering on the Milky Way. Probably homogeneous as an incipient nebula, by what means the misty primitive matter evolved into separate discrete elements, is one of the many profound mysteries in Nature. Neither can the force be explained which originated its rotation, and finally resolved the nebula into a series of gigantic ball furnaces, hotter by far than the fiercest heat artificially produced. The final issue, only, we apprehend in the many "elementary" substances which, separately or combined, make up the Earth upon which we dwell. It seems not unreasonable to deduce from these conclusions that our Planets, being simply off-shoots or detachments from the Sun,

that is, "Samples of the bulk," partake substantially of its nature and constitution. And spectrum analysis has verified this conclusion to a remarkable extent. Twelve terrestrial "elements," including hydrogen (representative of water; and, although lightest of all the elements, yet gives three lines in the Spectrum); sodium (the principal metallic base in sea-water), calcium (lime and limestone rock), and iron; all which rank among the commonest elements on Earth, are found in the Solar spectrum; whilst aluminium (the base of clay), carbon and oxygen (essentials in organised structures), copper, lead, and five other elements, are believed by Peck, upon strong evidence, also to be present. Chemists have long suspected substances like carbon, sulphur, phosphorus, chlorine, and iodine, to be compound and not elementary; and the spectroscope has greatly strengthened this suspicion: indeed, the supposition is neither improbable nor unphilosophic which would see in every single line of the thousands contained in the spectrum (with possible exceptions however, as in the case of Sodium with its double line), the specific evidence of one single and, perhaps, indivisible element. The present difficulty lies in the frequent inability of the eye to distinguish between excessively close and fine lines, and the tendency of the terrible heat of the Sun (Lockyer describes it as "beyond all definition") to dissociate or break up the so-called elements into finer and yet finer conditions of matter, the spectra changing with every separate crisis. It would even seem to be within the limits of possibility that, given adequate heat, possibly far exceeding that in the Sun, the final simple element or elements might be obtained which lie at the foundation of all matter in the Universe. Lockyer expresses himself thus—"The spectroscopic phenomena observed are simply and sufficiently explained on the view that the so-called chemical elements behave after the manner of compound bodies." For thorough and exhaustive conclusions on the heat, matter, and general condition of the Sun, his opinion is that its spectrum should be widened out to the extent of 315 feet.

Turning now to the Stars, and to the answers given by the spectroscope as to the presence of Solar or terrestrial elements in all those Stars which were found bright enough to give visible lines, whilst the evidence received up to the present time scarcely

amounts to demonstration, it yet is significant that all discovery hitherto tends but to confirm the conclusion that matter in the Stars is mainly and generically the same as that which is contained in Earth and Sun. The delay in arriving at just conclusions arises from the differences existing amongst the Stars, caused chiefly, we doubt not, by their differences in development and temperature, the spectra ever changing according to dissociation or combination of their elements. Many years ago a difference was thought to have been detected between Sun matter and Earth matter. An unknown element was detected in the Sun, the lines of which could not be matched by any substance upon Earth. This new element was therefore called "Helium," because peculiar to the Sun. Strange to say, this substance has, within the past year, been shown by Professor Ramsay to be identical with a hitherto undiscovered element, existing in some earthy matter which he was examining. It may here be mentioned that spectrum analysis can detect the presence of some invisible substances to one eighteen-millionth of a grain or even much less. Thus, to recognise a new element as existing in the Sun, 92 millions of miles distant, and then, after many years, to identify, for the first time, the same element under our very feet, savours of romance even in science (justifying the adage that truth is sometimes stranger than fiction), and is also, to say the least, a curious link in the long chain of evidence which subordinates all other laws to the greater law of Continuity.

That no Sun or Star exists to or for itself, we take to be as absolutely certain as that "no man liveth to himself." All observation and scrunity of the Heavens, together with analogy, combine to show a wonderful unity and inter-dependence of Suns and Planets, existing, so far as we can see, throughout the Universe. Dark planets we cannot, of course, see; but, remembering that our Sun was at one time surrounded by eight brilliant miniature Suns, now all cooled or cooling down, we understand well what is meant when the telescope shows us tiny points of light sheltering under the wings of larger stars like Vega, Aldebaran, Rigel, and Regulus. Then there are fine double Suns like Castor, a 3·7 mag. revolving round the 2·7 mag. in 1,000 years; Gamma in Leo, a 3·5 mag. round a 2·0 mag. in 407 years; Gamma in Virgo, 3·25

mag. round a 3 mag. in 185 years, reminding us of our planet Neptune, which takes 164 years to revolve round our Sun; and lastly, the giant Sirius, 26 times heavier than our Sun, whose companion, six times heavier, was believed to exist, owing to changes in motion of the large star, long before a giant telescope discovered it in 1862. We may also name Theta in Orion, where seven Suns, how large no one can tell, owing to unfathomable distance, lie partly embedded in an enormous nebula; also the famous double-double Epsilon in Lyra, the smaller companions requiring 500 to 1,000 years to revolve round the larger, and each double perhaps 900,000 years round their common centre, the two debilissima and two or three others probably also forming part of the system. Amongst clusters, we have the Pleiades, 2,300 smaller stars controlled by ten or twelve giants; also the cluster in Hercules, 14,000 suns, all revolving round a common centre; and the "Magellanic Clouds" in the Southern sky, comprising in their 315 clusters and nebulæ a galaxy of glory unimaginable.

In the above examples, excepting the clusters, it is certain in some cases, and almost certain in others, that our Sun would be counted diminutive alongside these colossal luminaries; also when compared with such giants as Canopus, Arcturus, Procyon, Arided, Spica, and Fomalhaut. On the other hand, in crowded clusters, and amongst the small stars of the Milky Way, we certainly meet with Suns of a much inferior order, probably approaching Uranus in size, say 32,000 miles diameter, or even small as Earth itself before it had cooled down. Differences in degree of development are also observed, varying from bluish white stars, like Vega and Rigel, through middle-aged yellowish stars like Capella and our Sun, up to red advanced stars, like Antares and Betelgeux. In the law of Continuity we, thus, do not look for identity of detail or invariable sameness, but rather for such general variety in size, motion, age, etc., as may consist with substantial unity in structure and design. This unity, then, we find to exist between our Sun and the Stars. The Sun is a huge globe of gaseous and liquid matter, incandescent, emits light, gives out heat, and is rapidly moving through space. The same can be said of all the Stars. Elementary matter is also largely the

same in both. A goodly number of the Stars (and probably all) are also variable like our Sun, but with periods of variability from a day up to weeks, months, or many years. Gravitation is also the property of all, binding in one universal bond of union all Suns, Planets, Satellites, Meteoric, and Cometary Systems.

The above analogies, assisted by probability and unquestioned knowledge, the result of observation and experiment, prepare us for the further analogy of "Invisible worlds in outer space." We refer, of course, to dark solid globes like our Earth. Many millions of years ago, when the contour of the Heavens was vastly different to the present, and when our ever swiftly moving Solar System occupied probably a totally different part of space, our Sun, younger in years and much greater in diameter than now, must have appeared to a telescopist (supposing one to be there), at the distance of four year's light journey, as a large brilliant star, attended by three or four liliputian Suns, the remaining four nestling too closely to the large star to be distinguished. But what appearance would it now present, say, to a telescopist on one of the Planets revolving round our nearest neighbour, Alpha Centauri? All that he would see, in such case, of our glorious Sun, his splendid retinue of planets, satellites, and millions of meteor systems and comets, would be a little lonely star in a vacant portion of Cassiopeia. What then has caused the difference? Simply, the cooling down which all have undergone (the interior four planets having become dark and solid), in the terrible cold of outer space, with their consequent diminution in size and brightness. Applying these two illustrations to our present Heavens, we have the approximate history, past, present, or future, of all the stars now separately visible to the naked eye, and which number, on a clear night, about six thousand. Remembering that these six thousand lie at all distances from us, from twenty-five up to a thousand billions of miles or more, we see at once why so many stars appear as lonely or single. The distances between them and the Sun-like Planets vanish into nothing from our enormously distant point of observation. Nevertheless, in hundreds of instances, our telescopes do descry these Sun-like Planets, and have even traced them in their mighty orbits round their Primaries. These are the facts, made patent by ocular demonstration, which

go to show that just as our Sun controls dark Planets like Earth, and bright Planets like Jupiter, so Astronomers reasoning from analogy and continuity, assisted by telescopic scrutiny, have concluded that the same conditions likewise obtain in the case of the lucid Stars around us. The argument applies with concentrated force to those red advanced stars like Alpha Herculis and Mu Cephei, the greatest portion of whose Planets in all probability have died down to darkness and solidity long ago.

If further proof were needed, several instances might be named of short variable stars like Algol, where the darker Sun or Planet, in the course of its close orbit, actually intervenes between us and the primary, thus detracting from the latter's brilliancy, and giving rise periodically to that change in brightness which we characterise as variability.

The total number of Stars visible in largest telescopes has been variously estimated from thirty millions upwards. Of these only a very small fraction, about six thousand, are separately distinguishable by the naked eye, under favourable circumstances. Those of first and second magnitudes are undoubtedly much larger than our Sun, and, in some cases, as much larger as our Sun is than Jupiter. How many are smaller, it is not possible to say; but being certain that a considerable number of the lower magnitudes, like some in the Pleiades, appear so, only by reason of their enormous distance, we may not err, perhaps, if we regard each of these six thousand as, on an average, equal in bulk to our Sun. Let us also assign to each an average of eight primary Planets, as in our System, thus giving a total of 48,000 Planets, in addition to attendant Satellites, Cometary Systems, etc. Half of these 48,000 we will suppose to be incandescent like Saturn, and the remaining 24,000 to be dark and solid like Earth, Mars, Venus, and Mercury. Let us now divide this number, as a tribute to the majority of Sirian or "young" Stars, also to any faint Stars whose light may have become dim, and whose heat dulled, through age; and whose planets, therefore, may have already passed the life-bearing stage; and also as an allowance for any planets which, owing to excess or deficiency of heat and light, or other cause, have proved incompetent for the development of life. We thus arrive at twelve thousand dark

and, to all appearance, inhabitable planets. Ignoring for the present Mars, Venus, and Mercury, and taking Earth only as our guide in analogy, let us regard every fourth globe only as inhabited by organised life, short of Man. We are thus left with three thousand Planets controlled by Suns within the limits of naked eye vision, in which, according to all available evidence, furnished by Analogy, Probability, and Continuity, life, vegetable and animal, exists more or less abundantly.

The question now arises (and the answer will surprise those who have not considered the matter), "In how many of these three thousand worlds may we reasonably suppose the evolution of life to have culminated in responsible and intelligent beings like ourselves?" This question is answerable only by asking another, "When did the life-bearing stage commence upon Earth?" Even Geology, with all its wonderful discoveries, fails us here. Authorities vary in their estimates, but all speak of millions of years. Shall we say, just to give point to thought, not less than seven, more nearly twenty, and just possibly forty millions, these being followed by the small fraction of seven thousand years covering human probational history; that is, the history of Man as the final product of physical evolution, he alone combining within himself all the tremendous issues of the past of Earth, with all the possibilities of an illimitable and evolving future. These figures, which, if the reasoning be just, or approximately so, by no means exaggerate the final result, indicate, by the following simple ratios, the number of planets now inhabited by human or intelligent life, and now controlled by those Star-suns which the naked eye can descry on any clear night in the Heavens above and around us. The total life-bearing period of each planet (continuing for seven, twenty, or forty millions of years) is to the total human life period (say seven thousand years), as the number of present life-bearing planets (three thousand, as before named) is to the number of planets now inhabited by intelligent beings like ourselves. The ratio or answers are as follows:—3 planets, if the average life period of the 3,000 be 7 million years; 1·05 if 20 millions; and 0·525 if 40 millions.

Thus, by calculation based upon averages, supported by analogy, probability, and continuity, we reach the singular result

that out of the 48,000 planets controlled by Suns visible to the naked eye, only three thousand can reasonably be regarded as inhabited at the present time by vegetable and animal life, short of man; and that only the very small average fraction of 1·525 (that is, less than two) can fairly be looked upon as the present abode of moral and responsible creatures like Man. These figures, it will be noted, do not touch our conclusion that the 48,000 planets referred to, pass, with probable exceptions, arising from various causes as already named, through the life-bearing stage at one portion or another of their histories.

Instead of limiting the enquiry to the six thousand Suns, which our unassisted vision can distinguish on a clear night, let us extend it to that vast multitude of Stars which lie within the reach of our largest telescopes and most sensitive photographic plates. Estimating these at the modest number of twenty millions, we obtain, by the same process of calculation, a residual of ten million worlds inhabited by inferior animal life, and 5,083 inhabited by moral and intelligent life, similar to our own.

The argument for worlds of life in outer space is well summed up in that epitomised history of Creation, which fitly stands at the head of the noblest revelation given to man. In its veiled sentences, the student will find, in simple and majestic language, not only the beginning of all Earthly things, but in stately order, and in measured pace, the unfolding of the Divine plan, and finally, the secret told, the why and wherefore of it all—the evolution of man. As in matter, we read the spiritual made manifest, so in man we read matter made spiritual. In the light of this ancient story, the immediate end, the object of the invisible worlds in space, whatever be their ultimate destiny, stand revealed. Like our Earth, they are the homes in which are born—the nurseries in which are taught—the schools in which are trained, often "through much tribulation"—the children of God.

Preservation of Algæ.

ACCORDING to W. A. Setchell and W. J. V. Osterhout, the selection of aqueous media for preserving algæ for class purposes is a matter requiring careful consideration. They find, too, that no one medium can be used indiscriminately for all kinds of material. The *Cyanophyceæ* are best prepared with a solution containing 1 per cent. each of chrome alum and formalin. The gelatinous sheath and matrices are rendered firm by this solution, the cell contents are kept in a very natural condition, and in most cases the colours are retained in their ordinary tints. Formalin solution, 1 to 2 per cent., preserves the cell contents very well, but does not preserve the colours or the softer gelatinous sheaths and matrices. Camphor water fails with many blue-greens, and is not strong enough for species preserved in the mass and associated with many bacteria. The *Chlorophyceæ* are very satisfactorily preserved in any of these media, but chrome alum is preferable in most cases, though membranaceous forms—like *Ulva lactena*, etc.—are rendered very brittle, and are, therefore, better placed in simple formalin solution. The *Phæophyceæ* do well when placed immediately in 1 per cent. chrome alum for three to six hours, and then preserved in 2 per cent. formalin solution or camphor water. Specimens for crushing may remain indefinitely in chrome alum solution. The coarser forms of the *Rhodophyceæ* may be kept in excellent condition in any one of the three solutions recommended, chrome alum preserving more colour than formalin or camphor water. For finer study, specimens are best left in a concentrated solution of picric acid in sea-water for twenty-four hours, then washed in plain sea-water for twenty-four hours longer, and preserved in camphorated sea-water.

Such genera as *Nemalion*, *Champia*, *Rhabdonia*, *Cystodonium*, etc., respond best to this treatment. Delicate species, like *Griffithsia bornetiana*, *Calithamnion baileyi*, *C. borreri*, *C. seirospermum*, etc., must be placed in 2 per cent. formalin in sea-water, with plenty of fluid, so as not to be crushed, and though the colour disappears, the cells keep their shape and the plants present a life-

like appearance so far as form goes. To prevent *Dasya elegans* dropping its hairs, and the more delicate species of *Polysiphonia* breaking up into short pieces, they should be put, whilst fairly fresh, into formalin or chrome alum solution.—*Bot. Gazette.*

Predacious & Parasitic Enemies of Aphides (including a Study of Hyper-Parasites).

By H. C. A. Vine.

Part IV. (continued). Plates XIII. and XIV.

Capsus Lanarius. Anatomy of the Imago.

THE change involved in the casting of the nymphal skin of this species is much greater than is the case with many others of the order. The most striking feature of the nymph, the numerous tufts of elongated, flattened appendages, which, for want of a better name, I have called 'hairs,' have wholly disappeared, and the abdomen, which has no longer the distended appearance of the nymph, is become chitinous, shining, glabrous, brown to black in colour, though sometimes yellowish beneath, and clearly segmented ; in the female the dorsal surface of the posterior segments of the abdomen is divided by two horny ridges, between which an ovipositor of beautiful construction (Fig. 6, Pl. XIV.) is extruded as occasion requires.

The abdomen and the major part of the thorax is now completely hidden by the extensive hemelytra, which, with the evolution of the scutellum and the development of colour, make so great a change in the general appearance of the insect as to make it difficult to believe that only a cast skin stands between it and the nymph.

The Head of the Imago.

The head has wholly lost the elongated and somewhat angular appearance which was characteristic of the larva. It is now broad and flat, the length at the most not exceeding the

width between the top of the eyes, and the entire width being as nearly as possible two and a-half times the length. The projection of the labrum is much less obvious than in the larva, no doubt from the modification in the proportions of the parts ; the differentiation of the 'face' into the central lobe and the *genæ*, or cheeks, is generally well marked, and the attachment to the frontal thoracic segment—the *pronotum*—is by means of a narrow collar. The surface is smooth, impunctate in all specimens I have seen, free from hairs or bristles, and varying in colour from black to reddish brown and ochreous yellow.

The Antennæ.

These organs are equal to or exceed, in length, that of the entire insect, and are strongly characterised by the contrast between the anterior and basal joints. The substantial first joint is about one-eighth to one-tenth the length of the entire organ, and is slightly inflated rather in advance of its centre ; it is approaching, or quite, black in colour, and is fairly covered with rather long, thin hairs of ordinary structure. The second joint occupies fully one half of the entire antenna in average specimens. It is towards the base narrow, rigid, and very distinctly black ; the central portion in pale specimens is usually yellow, and in dark specimens nearly black, and increases somewhat in size towards the final portion, which is enlarged and ends with a square shoulder, and has a slightly domed transverse termination. The whole of the joint is regularly clothed with stiff, fine hairs of ordinary structure, partaking usually of the colour of the derma, from which they rise ; towards the thickened end they become much more dense, and are also slightly longer and stouter ; the colour is here very black.

The two final joints are together about three-fourths the length of the second joint. They are parallel-sided and are considerably less in diameter than the preceding joint at its narrowest point, sparsely clothed in fine even hairs, which differ considerably from those found in the same situation in the nymph. The colour of these segments varies in different specimens from yellow to brown or black ; the final joint is usually about two-thirds the length of the third joint, which it otherwise resembles in every respect.

The total length of the antennæ averages about one-fifth of an inch.

The Rostrum.

This organ serves its most important uses in the earlier stages of the life of the Hemipteron, and in the imago is, in proportion to the remainder of the insect, distinctly smaller than it was in the fully-grown larva or nymph. It consists of the various organs already described in the last part, and is in frequent requisition for the piercing of aphides.

The Thorax.

The thorax is, to a great degree, hidden in all Bugs by the hemelytra. The pronotum (the dorsal aspect of the anterior segment) in *Capsus lanarius* is exceedingly narrow in front, not much exceeding the width of the head between the eyes, and wide behind, the sides sloping very sharply. It varies in colour from black in dark specimens to yellow in some pale ones, and is closely punctured over its entire surface.

The scutellum, which is the only other portion of the thorax visible when the hemelytra are closed, is of medium size, almost equilateral and domed. The colour varies from black to yellow, and the surface is rather sparsely punctured with finer punctures than the pronotum and elytra. Beneath, the coxæ, the large size of which is characteristic of the genus, are the most obvious features.

The Hemelytra and Wings.

The coriaceous portion of the hemelytra is well developed in *C. lanarius*. From the point of attachment to the mesonotum to about three-fourths of the entire length of these organs they are of a thick horny structure, in which the ridges separating the various parts are very prominent. This portion is thickly and deeply punctured, but otherwise somewhat shell-like in texture and without hairs except at the apex. Each hemelytron consists of corium, clavus, cuneus, and membrane. The cuneus is separated from the corium by a deep indentation, a trace of which is prolonged across its width, giving the apical portion an appearance of almost separation. The cuneus is sharply pointed at the exterior edge, and is here almost black; above which is a patch of bright

scarlet, the colour gradually losing its intensity as it recedes from the apex, which is covered with fairly thick black or brown hairs.

The membrane beyond the coriaceous portion, forming about one fourth of the entire length of the organs, is very finely rugose, blackish or brown in colour, usually with a light or clear patch below the final extremity of the coriaceous portion. It is strengthened by a thick nervure, extending in an oblong loop from one ridge of the corium to another, and the space enclosed is divided into two unequal cells by a similar nervure traversing it longitudinally. Some part of these nervures, which appear to be continuous with the substance of the corium, are often almost as brilliant in colour as the cuneus. The hemelytron is shown, sufficiently amplified for these details to be readily seen, on Pl. VIII., at Fig. 4, in our last chapter.

The membranous posterior wing, which is only visible when the insect is about to take to flight and the wings are expanded, resembles in many respects the corresponding organ among the Coleoptera, (although of course without provision for folding transversely) as may be seen by a comparison of the drawing, Fig. 5 on Pl. VII., with that of *Coccinella bi-punctata*, delineated on Pl. VIII. of the previous volume; but the arrangement of the nervures is different in the various families, and although in the *Capsidæ* the projecting hook-like development of the nervure forming the upper side of the cell, which is found in some genera, serves for a sectional division, it is not always to be depended upon, as it is sometimes scarcely developed, and in one family, which I have not had an opportunity of examining, is stated to be sometimes present and sometimes absent altogether. The membrane is covered evenly, but not quite closely, with short, regular hairs, and is fringed with very fine hairs of somewhat greater length, which, along the nerve which forms the upper edge, assume the appearance of very minute short spines.

The Legs of the Imago.

The last appendages of the thorax to be noted are the legs, which afford some useful features for generic division in the *Capsidæ*. The coxæ in this family are generally very much developed, and the tibiæ are sometimes furnished with spines at

regular intervals, as in *Plagionathus* and *Orthocephalus*, which are characteristic. The tarsi are three-jointed.

The Abdomen of the Imago.

The abdomen in the *Capsidæ* is much softer in its structure than is the case with most other families of the order. In *Capsus lanarius* it is somewhat short and fairly wide ; the number of segments which may be readily observed does not exceed eight, but the generative segments comprise the representatives of two or three other segments, so that some of the best writers on the Hemiptera give the total theoretical number of segments as eleven. In *Capsus* the females are provided with a beautiful and strangely constructed ovipositor, contained, when retracted, within a groove formed by a pair of horny ridges on the under surface of the abdomen. In the male, the only external evidence of the organs of generation consist of a pair of "genital styles," which are found at the extremity of the abdomen.

The Ovipositor.

This organ consists of four chitinous blades, somewhat broad and short, slightly curved and widened towards their points, somewhat after the shape of a flat spear-head. The organ is figured on Plate XIV., at Figs. 6, 7, and 8. The two outer blades, *a* and *b*, can scarcely be said to form a sheath for the stronger blades within them, but it is more probable that they fulfil the part of lancets, and pierce the surface on or in which the egg is deposited, leaving the central blades only the function of passing on the egg.

Both pairs of blades are strengthened by a narrow chitinous rib, and towards their extremities the lancet blades are finely serrated on the outer surfaces, giving to the edges the appearance of a saw. In *C. lanarius* also several larger teeth, independent of the serration, are visible on the outer edge, but these I have not observed in any of the other species, which are furnished with a similar ovipositor. The central ribs, which give the necessary rigidity to the ovipositor proper and to the lancets, coalesce in pairs at the base of the organ, and joining beneath it, so as to form a ring, through which the base of the ovipositor proper is attached to its muscular supports, they continue into the lateral

parts of the abdomen, where they are attached to the various muscles by which the parts of the organ are actuated. The action of the outer lancets appears to be of a rasping rather than a cutting nature, and as, in the instances of which I have definite knowledge, the eggs are placed upon the surface of leaves, it seems likely that the function of these organs is to roughen the surface, or to irritate it, so as to render it fit for the reception of the eggs.

The Internal Anatomy.

The alimentary organs are of a much simpler type than obtains in those insects which have been hitherto described in these pages. The suctorial tube of the rostrum passes on the juices which it has extracted from the victim through a pharynx surrounded by a mass of spiral muscles to an œsophageal passage, which receives in its course the secretion of two or four attached glands, which may be presumed to be salivary in their functions. There is no organ in any way analogous to the sucking stomach of the diptera, but the juices pass directly to an elongated vessel which answers the purpose of stomach and intestine, but in which it is difficult to allocate the limits of the respective functions. Some vessels discharge into this organ at a point which is probably the termination of the stomach proper. It has been suggested by Burmeister that these are of a urinary nature, but from their position and structure in the specimens, which I have examined, I should be more inclined to think they may be biliary in function, if I ventured to differ from so responsible an authority on insect anatomy.

The intestine terminates in a short, slightly expanded tube, which opens at the extremity of the abdomen, forming the anal orifice. In the female the sides of the abdomen are occupied by the ovaries, in which the elongated eggs lie clustered in an oblique position, ready for their passage to the ovipositor. I have always observed that the ova are all about the same size and apparently equally developed, while I have not found any appearance of immature or rudimentary ova which, by successive development, would keep up the supply. From this it would seem that the eggs of these insects must be comparatively few in number, and that the first development of the ovaries probably represents the extent of the maternal effort. The spermathecæ which are mentioned by

some writers have escaped my own observations; but the analogy which the organs present to those of other insects renders their existence pretty certain. The male generative organs may, in a good specimen, sometimes be traced lying along the central part of the abdomen, and consist of testes with subsidiary glands, and a narrow canal with an ejaculatory duct; but the parts are so fragile and difficult to observe in juxtaposition that I could not make a reliable drawing. The remaining internal organs follow closely the lines found in other nearly related insects, and do not present many features of special interest.

The second aphidivorous genus of the *Capsidæ* is *Plagionathus* (Fieb.), which includes nine species found in Britain. Several of them are figured on Pl. XIII., and it will probably be found that most of them are occasional, if not habitual, Aphis-eaters. They are generally narrow and oblong, and are distinguished from other genera, having a similar hook-like projection of the nervure in the membranous wing, by the presence of all the following features:—The tapering antennæ, black or dark-brown spots or spines, or both, on tibiæ, and a glistening surface clothed with short, fine black or silvery hairs.

The species are very widely distributed, and some, including *P. arbustorum*, the known aphis-eating variety, are very common. *P. arbustorum* may often be found upon nettles, but wild cornel, angelica, red currant, and rose, at times all become its temporary habitat, and probably many other aphis-haunted plants are visited by it. Mr. Watkins has communicated to me his observation of the presence of the imago on Angelica in mid-winter, and there is no doubt that it frequently hybernates in sheltered situations. The aspect of the insect varies very considerably, it being variously described as ranging from almost wholly black to dull yellow. I have myself seen none but ochreous yellow specimens, some having more black than others; but in all, the black margins of the light-coloured femora and two first antennal joints suffice to identify the species.

Mr. Saunders tabulates the species as follows:—

1.—Vertex with a distinctly raised carina, antennæ short, with second joint longer than third and fourth together ... ... *Roseri.*

2.—Vertex without a distinctly raised carina, third and fourth joints of antennæ together longer than the second. .

3.—Male more parallel-sided and elongate than the female, femora pale, spotted or lined with black, or surface clothed with silvery white hairs.

4.—Surface clothed with silvery hairs ... ... *Albipennis.*

5.—Surface not clothed with silvery hairs.

6.—Femora margined with black ... ... *Arbustorum.*

7. –Femora spotted at apex, but not margined with black ... ... *Viridulus.*

8.—Male and female, nearly alike in shape, femora dark or red, upper surface not clothed with silvery hairs.

9.—Spines of tibiæ strong and black, arising from black spots.

10.—Base of corium pale ... ... *Bohemani.*

11.—Elytra entirely dark.

12.—Larger, a pale spot near each eye ... ... *Nigritulus.*

13.—Smaller, head entirely black ... ... *Pulicarius.*

14.—Tibiæ, with fine black spines not rising out of black spots.

15.—Base of the elytra pale ... ... *Saltitans.*

16.—Base of elytra concolorous with the rest ... *Wilkinsoni.*

P. albipennis, *P. arbustorum*, and *P. viridulus* are the commonest species, and I think it likely that all are aphidivorous, though definite proof has only been obtained in regard to the second species. I have been unable to secure any specimens which could be certainly identified as the larval and nymphal stages of *P. arbustorum*, but the imago is shown on Pl. XIII. at Fig. 1. The antennæ and the characteristic tibiæ are given on Pl. XIV. at Figs. 1, 2, and 3.

The colour of my specimens, as I have already mentioned, is ochreous throughout, with some points of deeper orange, and hairs, spines, parts of antennæ, etc., black or very dark brown. The external anatomy of the imago differs in some important respects, besides the more elongated shape, from the Capsid last considered, and the following points are of interest:—

The Head.

The head is of average proportions, with a prominent labrum, of a black or dark colour as far as a line drawn across behind the eyes. Behind this is a band of lighter colour, greenish grey to yellow. The surface is clothed with fine hairs, and a number of long, coarse black hairs, almost bristle-like in texture, are very obvious. In common with the other genera of this family, the ocelli are wanting; but the perfect development of the eyes is a characteristic feature. The eyes stand out on either side of the head like two spheres attached to it by about two-fifths of their surface only; the facets are large and very clearly defined, and regular to the edges of the organs, and on the posterior side, where in many species the lenses fade and the pigment is deficient, both are in *P. arbustorum* as sharp and perfect as elsewhere, except on a small, clearly-defined, semi-circular space next the pronotum, where they are altogether absent.

The Rostrum.

This organ, which is four-jointed, differs little from that of *C. lanarius*, already described, but the basal joint is more voluminous and of a more chitinous texture.

The Thorax and Wings.

These structures also present much the same features as in the Capsid already described. The Hemelytra are considerably longer and narrower, and are clothed, as to the coriaceous part, with short, fine black hairs, which frequently appear silvery in reflected light. The membrane is dark, with a translucent spot behind the cuneus.

The Legs.

The most characteristic features of the species are to be found in the femora and tibiæ, the former of which are always outlined and sometimes spotted with black or very dark brown. The tibiæ are pale, usually ochreous, and provided with a number of fine black spines, each of which rises from a patch of brown upon the integument; the extremities of the tibiæ and the whole of the tarsi are also black.

Among the *Cimicidæ*, one sub-family, the *Anthocoridæ*, is probably the best-known of the Aphis-eating Hemiptera.

The *Cimicidæ* comprise four sub-families, and probably a carnivorous habit prevails throughout the group to a greater or less degree. The following characters, given by Saunders, will enable the student to determine to which division any detected aphis-eater may belong :—

1.—Rostrum 3-jointed, tarsi 3-jointed.
2.—Ocelli absent ... ... *Cimicina.*
3.—Ocelli present.
4.—Antennæ very long and thin, clothed with long hairs, third and fourth joints together twice as long as first and second ... ... *Ceratocombina.*
5.—Antennæ not very thin, not clothed with long hairs, and third and fourth joints not nearly twice as long as the first and second ... *Anthocorina.*
6.—Rostrum 4-jointed, tarsi 2-jointed ... *Microphysina.*

The sub-family, *Anthocorina*, includes eleven genera found in Britain :—

1.—Third and fourth joints of antennæ very fine and thin, clothed with long, erect hairs.
2.—Anterior femora, hardly thicker than the intermediate pair ... ... *Lyctocoris.*
3.—Anterior femora incrassated, much thicker than the intermediate pair ... ... *Piezostethus.*
4.—Third and fourth joints of the antennæ, scarcely or not thinner than the preceding, hairs, not long and erect.
5.—Cell of the wing, with a hook-like nerve.
6.—Pronotum, with a distinct apical collar.
7.—Apex of the metasternum between the coxæ, widely truncate.
8.—Rostrum, reaching to the intermediate coxæ.. *Temnostethus.*
9.—Rostrum, not reaching beyond the centre of the mesothorax ... ... *Elatophilus.*
10.—Apex of metasternum, rounded and narrower.

11.—Rostrum short, hardly reaching beyond the anterior coxæ.

12.—Apical collar of pronotum long, sides gradually diverging from it ... ... *Anthocoris.*

13.—Apical collar short, sides widely rounded behind it ... ... *Tetraphleps.*

14.—Rostrum, reaching to intermediate coxæ ... *Acompocoris.*

15.—Pronotum without a distinct collar ... *Triphleps.*

16.—Cell of the wing without a hook-like nerve.

17.—Species robust, pubescent.

18.—Head short, scarcely longer than its width between the eyes ... ... *Brachysteles.*

19.—Head much longer than its width between the eyes ... ... *Cardiastethus.*

20.—Species elongate, glabrous, parallel-sided ... *Xylocoris.*

Of these genera, the first, *Lyctocoris* (Hahn.), is certainly carnivorous, preying upon the small insects found in the rubbish which forms its usual habitat, and I have strong reason to think that the second *Piezostethus* (Fieb.) is not only an insect-eater, but an aphis-eater, attacking the melon aphis and other species which are found in the hot beds which it usually haunts. Its habits in this respect render it a very convenient species for study.

Anthocoris (Fall.).—The genus may be readily recognised by the following characters :—Head with eyes not touching the pronotum ; ocelli placed posteriorly, close to the inner margins of the eyes ; antennæ with second joint not nearly so long as the third and fourth together ; rostrum short, reaching to about the anterior coxæ ; pronotum, with well-marked apical collar, sides behind it more or less rounded, base largely sinuate ; scutellum impressed at the apex ; 'elytra always developed, their sides sub-parallel or slightly rounded ; legs simple, posterior coxæ close together, the metasternum produced between them in narrowly rounded lobe.' Six species are known as British and may be distinguished as follows :—

1.—Elytra in part dull.

2.—Corium entirely shining, except at the extreme base ... ... *Sarothamni* (Douglass & Scott.)

3.—Corium dull except towards the apex .. *Gallarum ulmi* (De Geer.)

4.—Corium entirely dull.

5.—Cuneus entirely shining .. ... *Nemoralis.* (Fabr.)

6.—Inner angle of cuneus dull.

7.—Larger, head and pronotum black ... *Confusus.* (Reuter.)

8.—Smaller, head and pronotum in front red ... *Visci.* (Douglass.)

9.—Elytra entirely shining ... ... *Sylvestris.* (Linn.)

Probably all these genera are carnivorous and aphis eaters, and it will be observed that each species haunts plants or shrubs which are usually frequented by aphides in great numbers. *A. sylvestris* is well known to the hop growers as a frequent visitor on their limes, but they are far from recognising its beneficent mission, as they very generally believe it to be injurious to the vegetation. If the hop farmers had studied the matter with as much interest as they bestow upon the liquids with which they endeavour to destroy the aphides by "washing," they would have discovered that the "needle-nosed fly," as they call it, is an active ally, and passes its life destroying the aphides which really do the mischief, which the farmer attributes to the bug.

I have frequently seen *A. sylvestris* transfix a juicy aphis (and it appears to me to exercise some discretion in this respect), and after the gentle, or violent, as the case may be, insertion of the lancets of its rostrum, to remain motionless, save for the rhythmical movement due to the pumping action of the muscles, while the aphis, sometimes quiescent and sometimes struggling, collapses gradually, and is often at last lifted, an almost empty skin, upon the rostrum of the attacker, to be presently contemptuously cast aside, though still with the ability to feebly use its legs and move away. Mr. C. J. Watkins has kindly informed me of several similar instances, and Mr. Maclachlan in the *Ent. Proc.* remarks on its activity in attacking Aphides in the hop gardens. I have figured *A. sylvestris* on Pl. XIII., at Fig. 2, and also the immature larval form at Fig. 3. The characteristic hemelytron and antenna are shown, along with those of *P. arbustorum*, on Pl. XIV., Figs. 4 and 5.

The most characteristic details shown in these figures will enable the reader to appreciate the main features of difference between this genus and those already described and figured without the wearisome repetition of detailed description. The colouring is always more or less dull, and partakes of yellow, brown, and black, and the general aspect of the insects, especially as to the head, is somewhat long and pointed in comparison with Capsus, and, though not so narrowed as Plagionathus, the head of the latter is much more obtuse.

To facilitate the recognition of other species of the genus as aphis eaters I have drawn also on Plate XIII., figures of *A. nemoralis*, *A. gallarum ulmi*, and *A. visci*.

The development of the *Hemiptera-Heteroptera* is still very obscure, and, in view of the difficulties in the way of investigation, nothing short of an exhaustive study of the whole subject with the advantages of a suitable insectary and other conveniences will avail to put us in possession of the consecutive phases of these insects' history. I myself have made many attempts during the past two years to observe the development, but have been met by great difficulty in obtaining eggs which had any reasonable certainty of being those of the insects in question. The ordinary sources of supply appear unable to provide eggs of plant bugs, and they seem to be very rarely observed on vegetation, while I have never known the female produce eggs in confinement.

So far as I can judge from fragmentary observation, the eggs are laid about the middle of spring, and it is some weeks frequently before the young are hatched. The eggs are elongated, and are attached usually to vegetation in layers or groups, the upper or free end having some sort of ridges or spines around it, and the colouring varying from quite pale to a deep brown. The young, on leaving the egg, shows little of its ultimate shape, this only developing when the first moult takes place, which is some fourteen or fifteen days after its emergence from the egg, and seems to depend upon the supply of food. Meanwhile, a small oblong insect, considerably wanting in development, except as to its rostrum, is the larval representative of the future Hemipteron. After the skin is first cast, some of the recognised characters of the sub-order become apparent, and it is in some cases possible

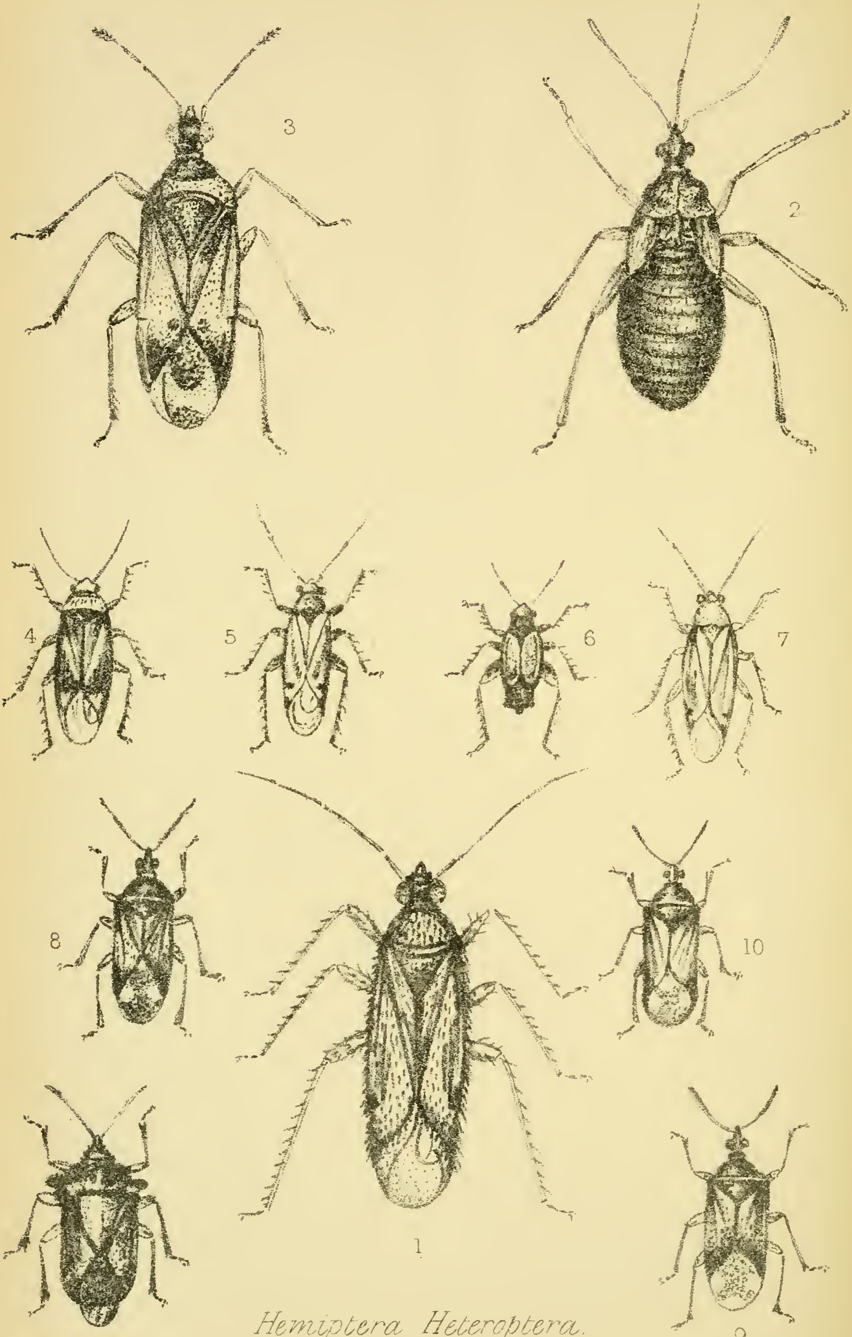
(as in the case of *C. lanarius*) to say to what family the larva belongs. The carnivorous species, during their earlier existence, are chiefly dependent upon their vegetable hosts for their nutriment; but after the moult more frequent attacks upon Aphides, and other small insects, may be observed, even in confinement; and I have noted that, when so kept, recurrence to vegetable juices is much more general than when the insect is in its natural habitat. Some three to four weeks is the apparent duration of the larval condition, and at this time the insect disappears from its ordinary haunts, and, hidden in some deep crevice, divests itself of its larval envelope, appearing again with the wing-pads and developments of detail of the nymph or pupa. So well does the insect conceal itself at the time of change that I have never succeeded in finding a cast skin.

The nymph is much more sturdy (in *C. lanarius*, which has been the principal subject of my observations) and rapacious than the larva, and frequently accounts for a considerable number of Aphides—always, I think, in the larval form—in a short space of time.

A specimen taken in the nymph stage, after a short time, during which it appeared anxious to escape, attacked and consumed three aphis larvæ in the course of forty-five minutes. The period of existence in this stage seems very uncertain, and probably depends upon the atmospheric condition and the supply of food. Certainly, a very large proportion of the immature Hemiptera which I have taken from time to time are nymphs. A few days *may* sometimes see a change to the imago condition, but I have had a Capsid under observation for three weeks, and lost it without any development taking place.

With the final moult the voracity of the insect becomes much reduced, and it may now be more often found on plants which are not usually frequented by Aphides. The characteristic features also for the first time become clearly defined, and the modification in the number of joints in the antennæ, the rostrum, and the tarsi form valuable specific and generic indications.

The females of the *Capsidæ* and of some other groups which are similarly furnished with an obvious ovipositor are beautiful objects for microscopic study. The eggs are usually laid in rows



Hemiptera Heteroptera.

H. C. A Vine. ad nat. del   F. Phillips Sc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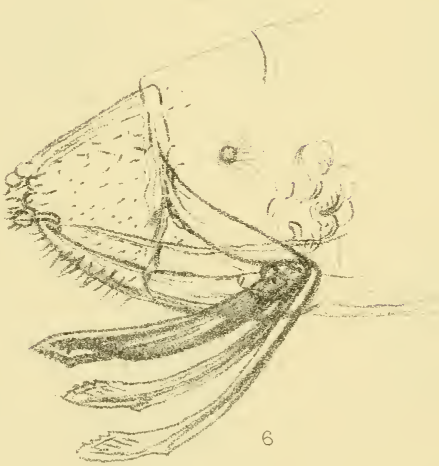
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8

Details of Aphidivorous Hemiptera.

H.C. Alvine ad nat. del. F. Phillips Sc.

or groups on leaves, or in many cases underneath bark, and probably, I think, in this latter situation survive the winter, though, as I have seen specimens of Capsus hybernating in December and January, there can be no doubt that some of the mature insects survive until spring to perpetuate their race.

The highly destructive system of the insect world is well seen in the vast proportion of the eggs of bugs which are pierced and destroyed by parasitic Hymenoptera. So much is this the case that it is very uncertain if a cluster of eggs will yield a single Heteropteron larva, their place being taken by minute Hymenoptera of similar species to those which we shall later on review as the chief destroyers of Aphides.

EXPLANATION OF PLATES XIII. AND XIV.

Plate XIII.

Fig. 1.—Imago of *Plagionathus arbustorum*.
,, 2.—Larva of *Anthocoris sylvestris*.
,, 3.—Imago of same.
,, 4. ,, *P. roseri*.
,, 5. ,, *P. albipennis*.
,, 6. ,, *P. saltitans*.
,, 7. ,, *P. bohemanni*.
,, 8. ,, *A. nemoralis*.
,, 9. ,, *A. gallarum ulmi*.
,, 10. ,, *A. visci*.
,, 11. ,, *Podisus luridus*.

Plate XIV.

Fig. 1.—Antenna of *Plagionathus arbustorum*.
,, 2.—Hemelytron of same.
,, 3.—Tibia and tarsus of same, exhibiting characteristic markings and spines.
,, 4.—Antenna of *Anthocoris sylvestris*.
,, 5.—Hemelytron of same.
,, 6.—Ovipositor of *Capsus lanarius*, *in situ* (from a balsam mount).
,, 7.—Ovipositor, separated.
,, 8.—One of the external blades or sheaths.

Technology of Diatoms.*

By J. Tempere.

Chapter III.—ON THE MOUNTING OF DIATOMS.

DIATOMS prepared as I have described in the preceding chapters are mounted in two ways—either dry or in a medium. These two methods apply equally well to mixed Diatoms—that is to say, to washings spread out on a thin plate—as to species that are sorted and isolated.

The Dry Method.

The mounting of Diatoms dry is the less used of the two methods; it requires more care and more attention than when a liquid is used, for it is necessary to exclude all trace of moisture in the cell and also to prevent its subsequent introduction.

Preparation of the Cells.—The cells should be made of a cement of black gum-lac, prepared as follows :—In a vessel of tin (a sardine-tin will do very well) you heap up white gum-lac to half its depth, and having made a saturated solution of aniline black in alcohol of 90° (absolute alcohol), pour enough of it over the gum to cover it; allow them to remain in contact for a few minutes, and then place the tin in a water-bath, stirring the mixture till the lac is completely dissolved; then, while warm, pass the mixture through muslin. In cooling, this cement becomes semi-liquid, and has just the consistence which it ought to have to meet the requirements of the operation. When, in consequence of the evaporation of the alcohol, it becomes too thick, a few drops of absolute alcohol may be added, taking care that it is well stirred up.

The cells—which ought to be made on the turn-table—should have always the same exterior diameter as the thin glass which is to cover them ; their thickness may vary from the 1/8th to the 1/10th of a millimetre. One good coat of cement is generally enough.

In order to make a good cell—that is to say, one that is not too large and of even thickness throughout—it is well to use a sable brush of the best quality, of which the hairs are not more

* Translated from *Le Diatomiste.*

than ten millimetres long. These cells ought to be prepared a good while in advance, so as to be perfectly dry and hard when they are wanted for use. Those of our readers who have a stove can accelerate the drying by placing the cells near it for a few hours.

To Spread the Diatoms Uniformly over the Thin Glass.

The Diatoms intended to be mounted dry ought to be held in suspension in distilled water, absolutely pure; that is to say, that when evaporated on a thin glass, it shall leave no trace behind. If they have been kept in *eau-phenique* or in alcohol (marine gatherings), these liquids ought to be entirely got rid of.

And here a little difficulty occurs which tact and practice will soon surmount; it refers to the quantity of Diatoms that ought to be contained in two or three cubic centimetres of distilled water, so that when once spread on the thin glass there shall be enough without their being superposed one on the other, or allowed to form into little masses, as frequently happens with the smaller species. As a general rule, you may say that the water containing the Diatoms in suspension should never have a milky appearance, but only a slightly opaline tint, especially when the small species are concerned. As to the medium-sized species and those still larger, it is desirable to see them individually float in the liquid.

The glass on which we are to spread the Diatoms ought to be thin glass (English No. 1), perfectly cleaned, for the least trace of greasy matter will cause an immediate retreat of the liquid, and the even spreading of the Diatoms will be rendered impossible.

I always take the precaution, in order to avoid this difficulty, to use new English glasses, which are cut mechanically and put up in 1-oz. and ½-oz. boxes, and have not been handled. These can be wiped between the finger and thumb with a bit of fine old linen rag, while they are held by the edge with the other hand. You may equally well use other glasses after they have been subjected to the following treatment.

The glasses are first placed in a 10 per cent. solution of carbonate of soda, in which they are agitated for some seconds in such a way as to bring all the surface into contact with the liquid. This liquid is poured off and twice replaced with distilled water;

after the second time, a little sulphuric acid is added, which neutralises the soda that remains and completely cleans the glasses. The least trace of acid is then removed by very pure distilled water, and the glasses are allowed to dry spontaneously, screened from dust; or, better still, they can be dried near a stove. There then remains nothing but to wipe them before using.


Fig. 18.

The glasses, being wiped, are placed at some distance from each other on a plate of metal or very level glass. You then take, by means of a pipette (armed with an elastic ball), Fig. 18, a certain quantity of liquid containing Diatoms in suspension, and these you have well mixed up with the pipette; then, whilst with one hand you hold the glass lightly with a mounted needle, you cover it with the liquid by lightly pressing the india-rubber ball. If the quantity spread appears too great, you can withdraw the desired quantity by reducing the pressure. A little practice will put you in the way of all the little details of this operation.

If the glasses are as they should be, the water will spread very evenly up to the edge. It will present a flat surface, never in bulges. Nothing now remains but to allow them to dry spontaneously, screened from dust, or dried by a stove, at a temperature of 40°C. A too-brisk dessication, or the use of too high a temperature, generally sets up currents, which cause the Diatoms to group themselves in little masses of a very annoying character.

Burning Diatoms on the Platinum Plate.

Certain gatherings, such as contain delicate kinds—especially marine species, which do not admit of the use of acids during the process of cleaning (almost all the marine gatherings are of this class), and which have only been treated with distilled water and the "tamisage"—ought to be at once spread on the glass and then treated to a dull red heat on a plate of platinum, so as to destroy the organic matters, which are found independent of the endochrome in which each frustule is contained, and of which the presence, now useless, tends to obscure the details of the siliceous carapace.

The small plate of platinum that is needful for this purpose should be neither too thin nor too thick. If too thin, it will present superficial irregularities, which will prevent the glasses from so resting on it that they may be altered in shape under the influence of the heat if it should be a little too great; and if too thick, it will cost more than is needful without corresponding advantage. That which I use measures 35 × 30 mm., and has a thickness of from 1/10th to ½. I hold it between the jaws of a little test-tube holder (Fig. 19), to expose it to the flame of a small spirit-lamp.

Fig. 19.

Three or four glasses of 16 mm. may be burnt at the same time on a platinum plate of the size I have indicated. It is placed above the flame and gradually lowered until it assumes a dull-red tint; you may in certain cases carry it as far as a cherry red, but with great care and for a very short time. In order to judge the better of the intensity of the heat as represented by the colour that the platinum plate assumes, it is well to conduct the operation in a feeble light. During the operation the surface of the glasses becomes, first, brown, then black, and then perfectly white, which indicates that the carbonaceous matter is all consumed, and it only remains to fix the glasses on the cells that have been prepared for them.

The glass slip, with the cell, having been wiped from dust, is slightly warmed over a spirit-lamp to drive off any moisture; or, better still, placed on a plate having a temperature of about 40°C. You place the thin glass with the diatoms downwards on the cell, and, holding the slip by one end, warm the other in the lamp-flame, pressing lightly and perpendicularly on the cover-glass with

a mounted needle. Under the influence of the heat the upper part of the cell softens, adheres to the cover-glass, and fixes it there in a manner absolutely hermetic. The plate, when cooled, is put on the turn-table, with a coat of cement to protect the edges of the cover-glass, and the preparation may be considered as permanent, unless after a certain time the cover-glass should crack and allow damp to enter.

Mounting in Resinous or Mixed Mediums.

This mode of mounting is that usually adopted, and, besides, it ensures absolute permanence if the media employed have been well prepared, and also the details of the more delicate of the siliceous carapaces of the Diatoms are most clearly shown, especially if the medium employed is one which possesses a high refractive index.

The Diatoms are spread on the cover-glasses in the way I have previously indicated. If the gathering or the deposit contains the larger species, it will be well to separate these from the smaller and to make separate preparations; that is to say, the result of the washing of this gathering should be divided into a heavier and a lighter part. This division, as I have explained in the chapter on "Cleaning," can be effected by repeated decantations, or, better still and in a more regular manner, by the employment of tamis-filters.

If the materials are the result of washings made with acids, and have been freed from all organic matter, the burning on the platinum plate becomes unnecessary. Only those special kinds which I have already mentioned require this operation. These materials, and also the lighter deposits, can be mounted directly in the balsam without it being necessary to fix the valves on the cover-glasses. It is not the same with the heavier kinds, for then a cover-glass carefully spread with Diatoms of large size becomes unsightly (affreuse), when heat is applied for hardening the resin, which developes bubbles of vapour that crowd the valves one on the other, causing them to unite in groups, and often driving them to the edge of the cover.

This fixation is obtained by placing the Diatoms that it is desired to spread and fix in water containing a very small quantity

of gum. This is how this water is prepared so as to have it always ready. You choose some bits of Gum Arabic, extra white, which are first washed and then dissolved in very pure distilled water. This solution, which should be very fluid, is then filtered twice through a double filter. You add to 100 grammes of equally pure distilled water some drops of the solution of gum. It is needful that the quantity of gum so added shall be enough to fix the Diatoms, and yet so thin that when dried it shall leave no trace on the glass—that is to say, that the film deposited shall be so thin as to be invisible.

The covers, thus prepared and well dried, are ready to be placed on the balsam.

Canada Balsam.—A certain number of resinous media have been, and still are, used for mounting Diatoms. First of all, Venice turpentine was used, and then Canada balsam, which is not really balsam, but simply a resin obtained from the *Abies Canadensis.* As it can be obtained very pure and very limpid, it is the medium most generally used in micrography.

The best preparation of Canada balsam for general use is obtained by allowing the balsam to thicken till it comes to the consistence of a very thick mass. You then add enough benzole to form it into a semi-fluid liquid.

You place a drop of this balsam on the slip of glass, and then, after having, by means of a pipette, applied a drop of benzole to the Diatoms on the cover-glass, and quickly placed the latter on the drop of balsam, causing it to be begin contact with the slip on the left, and lowering it gently towards the right, using a mounted needle. By this means you avoid the enclosure of air-bubbles, which, though they may be got rid of by employing heat, are nevertheless useless and troublesome. You then warm the slide on a hot plate, or above a spirit-lamp, to expel the benzole and harden the resin. The preparation, when cooled, is then washed and cleaned with benzine; then the cover-glass is sealed down with a coat of cement of black lac, so as to guarantee the preparation from all external agents. As Canada balsam has only a feeble index of refraction (1·52), it has long since been replaced, especially for the mounting of Diatoms, by Styrax and other similar balsams.

Styrax.—We have here a true balsam of a composition very complex, obtained from the *Styrax orientalis.* This balsam, of a deep brown colour, contains cinnamic acid, a near neighbour to benzoic acid, as well as numerous impurities, from which it must be freed. This is the method that I employ, and which is mainly that described by M. le Professor J. Brun for the preparation of Tolu.

The balsam of commerce is boiled with enough water (about twenty times the volume of the balsam under treatment), renewed twice; the floating mass, very soft after it is cooled, is then exposed in saucers and placed on a stove till it becomes brittle.

The mass is then dissolved in benzole, then filtered twice in a funnel, of which the upper part is covered with a plate of glass. The filtered portion is exposed, protected from dust, until by the evaporation of the benzole it acquires the desired consistence—a semi-fluid. The index of refraction of styrax is 1·62.

Balsam of Tolu, Liquid Amber.—It was M. le Professor J. Brun, of Geneva, who first proposed to employ balsam of Tolu to replace Styrax. Balsam of Tolu is obtained by making incisions in the bark of the *Toluifera balsamum.* Tolu is less dark than Styrax and is prepared in the same manner. In commerce you can meet with Tolu that has been deprived of the benzoic acid by washing with water. In this case, it is only necessary to dry the mass on a stove without further washing. The index of refraction of Tolu is 1·64.

Liquid Amber—which is extracted from *Liquidamber styraciflua*—is found in commerce in a fluid or viscous form. The latter is the only one for our use; in other respects, it has a close analogy with Tolu, without possessing any advantages.

Unless the various balsams (Canada balsam alone excepted) are prepared with great care, and completely free from the acids they contain, you run the risk, after a certain time, of seeing numerous crystals form in the mass—crystals that often make the preparation unfit for study. Their index of refraction is the reason for employing them, but their brown colour is disagreeable, and it is this, above all, that has always made me prefer the Monobromide of Naphthaline mixed with Canada balsam. Diatoms are mounted in Styrax Tolu in the same manner as in Canada balsam.

Nature of Monobromide of Naphthaline and Canada Balsam.—The Monobromide of Naphthaline is a liquid, very fluid, of a golden yellow when pure, very subtle, and very penetrating. Its index of refraction is 1·65. In mixture with Canada balsam it constitutes a medium of a clear and agreeable colour, and still possessing an index of 1·62, which is equal to styrax.

The mixture is made by adding one volume of Canada balsam, very thick and very pure, to an equal solution of Monobromide of Naphthaline. They are agitated from time to time to cause an intimate union of the two, which then form a semi-fluid of a very clear yellow.

The use of this mixture for the mounting of Diatoms requires certain observations and certain precautions :

1.—It is absolutely necessary that the vessels in which the mixtures are made, and in which they are kept, should be kept absolutely free from all traces of moisture, and hermetically sealed.

2.—At the moment of mounting, which is done in the same way as with the other media, it is needful to pass the slip and cover rapidly over the flame of a spirit lamp to drive off all moisture.

3.—The mixture cannot be hardened without losing, in great part, its index of refraction, by the evaporation of a part of the Monobromide. These preparations should be allowed to dry spontaneously in the open air for some days, or for some hours in a stove from 30 to 40°C, after which the cover should be sealed down with two or three coats of lac cement.

THE MYSTERIES OF FLOWERS.—One of the most mysterious elements of flowers is the perfume, the essential action of which in plant-life cannot be demonstrated by the wisest of our scientific men. Gas can be weighed, but not scent. The smallest-known insect that lives in the heart of the Rose can be caught by a microscope lens and made to give up the secret of its organisation ; but what it is that the warm summer brings us from the wild flowers of the hillsides or wafts to us from the choice plants of the hothouse no man has been able to determine. So fine, so subtle, so imponderable, it eludes weights and measures.—*Journal of Horticulture.*

British Hydrachnidæ.

By Charles D. Soar. Part V. Plate XII.

In our last paper we considered the genus *Nesæa*. We will now turn our attention to *Piona*, a genus very closely allied to it.

C. L. Koch, in his *Deutschlands Crustaceans, etc.*, does not mention this genus; but in his *Übersicht*, 1842, he separates five species from the genus *Nesæa* (in which genus he had previously described them), and places them in a new genus, which he named *Piona*. The five species so separated from the *Nesæa* were *Piona ovata*, *P. rufa*, *P. viridis*, *P. affinis*, and *P. fasciata*, making *P. ovata* his type specimen. In 1879, Neuman put one species (*P. viridis*) back again into its old place, and in his *Swedish Hydrachnider* he also gives and describes this genus, adding five more species to the list already given—namely, *Piona fusca*, *P. mira*, *P. flavescens*, *P. lapponica*, and *P. abnormis;* but at the same time he expresses a doubt as to the propriety of the classification of all these species under one genus.

Neuman, however, appears to think that Koch had not sufficient data to warrant him in creating this new genus. I here give a translation from Neuman's work, *Swedish Hydrachnider*, 1879, p. 51, so that readers may see for themselves what he says:—

"In my account of the spiders and 'water-mites' of Gothland and Bland, I mentioned that I had long felt doubtful as to the propriety of classifying the species here in question under a separate genus, as they should perhaps more appropriately be brought under the head of *Nesæa*. As defined by Koch, the genus *Piona*—differing from *Nesæa* by the unequal distribution of the so-called 'dorsal stigmata' (or spots), and the absence of teeth on the fourth joint of the palpus only—does not appear to have any *raison d'être*. As regards the insubstantiality or incorrectness of making the said dorsal spots a basis of generic division, I have already expressed my opinion. The absence of teeth on the feelers might appear a better mark of distinction, but for the fact that it so happens that certain species of *Nesæa* have such small feeler teeth as to be imperceptible except when very strongly magnified, and that *Piona abnormis* is likewise provided with

similar teeth. The pointed projection or prickle, directed forward, which is set upon the point of the fourth joint, and which sometimes attains a length half as long as the fifth joint, appears, on the other hand, peculiar to this genus. Another and more essential difference between *Nesæa* and *Piona* appears in the formation of the 'fold of generation,' for in the case of the last named this has about the same form as in the case of *Limnesia* and *Hygrobates*; that is to say, the crevice is surrounded on either side by three stigmata only, while the genital fissure in *Nesæa* has numerous smaller ones on each side, which are quite different in shape to these."

It will therefore be seen that there are two very important features in which *Piona* differs from *Nesæa*, namely, the pointed projection or prickle on the edge of the fourth joint, which partly overlaps the fifth joint (see Pl. XII., Fig. 2, and the three genital pores on each side of the genital crevice (Fig. 3). These two very distinctive features, I think, are sufficient to warrant Koch in separating the mites which bear these peculiarities from the genus in which he had originally placed them.

In the extract given above from Neuman, the reader will notice two more genera mentioned—namely, *Limnesia* and *Hygrobates*, neither of which we have at present considered; but we shall come to them later on, when those interested in these creatures will be able to compare the drawings of the genital area one with another, and see how near the similitude is. That Neuman himself was satisfied with the separation of this genus from *Nesæa* is proved by his adding five species to the list.

Genus V.—*Piona.*

1842.—*Piona*, C. L. Koch, *Ubersicht des Arachnidensystems*, Heft 3, p. 13, Tab. 1, Fig. 4.

Body soft. All tarsi have claws. Legs have swimming hairs. Palpi not pincer-shaped, but on the anterior margin of the last joint but one is a short, peg-like appendage near the fifth joint. On each side of the genital crevice are three pores only. Eyes wide apart. Mandibles in two distinct portions; Epimera forming two groups on each side.

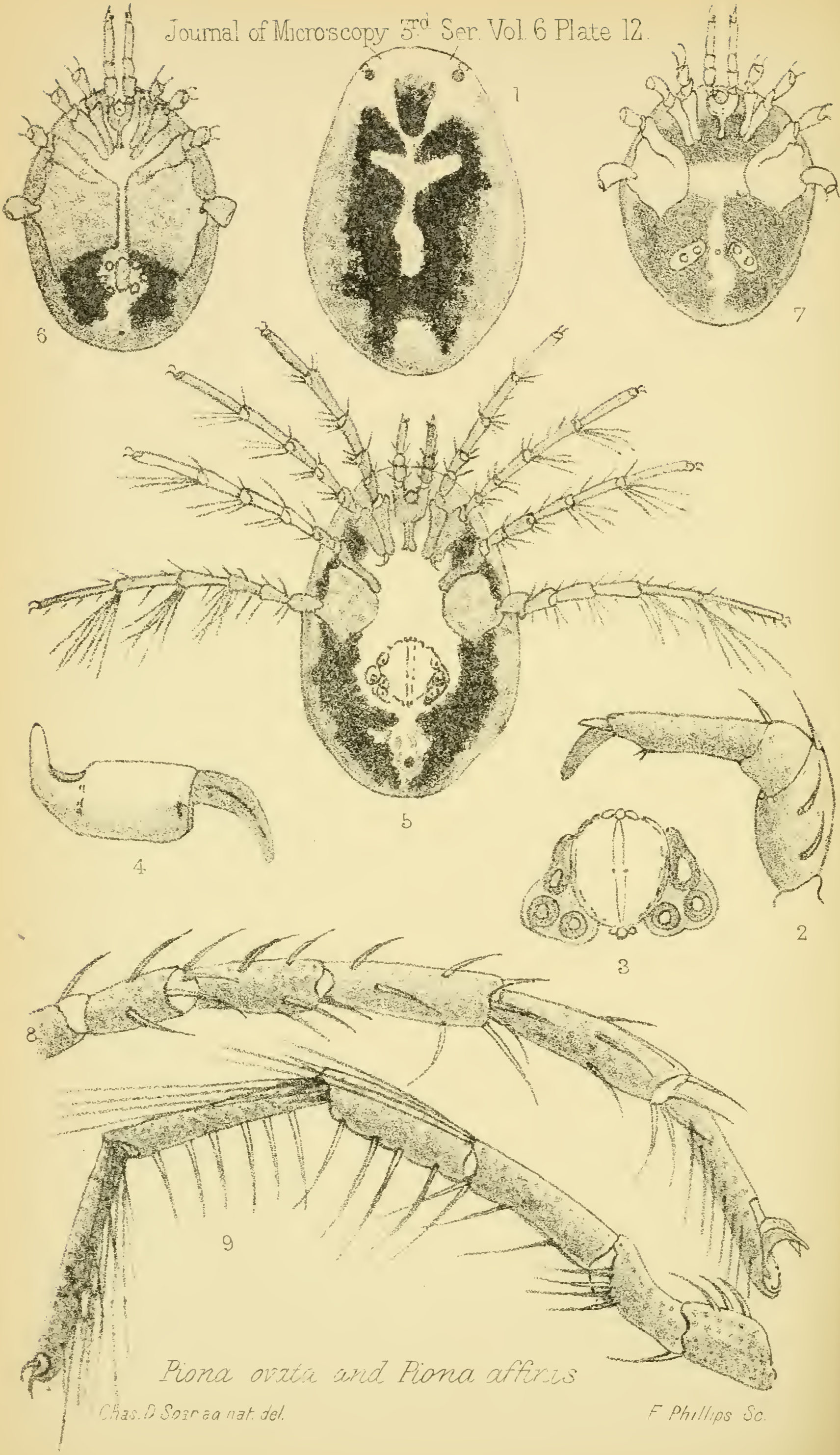
Piona ovata (Koch).

1835-41.—*Nesæa ovata*, C. L. Koch, *Deutschlands Crust.*, etc., N.S., Fig. 13.

1842.—*Piona ovata*, C. L. Koch, *Übersicht des Arachnidensystems*, Tab. —, Fig. 4.

1879.—*Piona flavescens*, Neuman, *Sveriges Hydrachnides*, p. 54, Tab. II., Fig. 4.

This I believe to be the same mite given by Koch as the type species of *Piona*, and also Neuman's "*P. flavescens.*" It is a very beautiful Hydrachnid, of a fair size, and brilliant in colour; its beauty cannot be seen in a black and white drawing. To be appreciated the mite must be seen in the life. The body is 2/25ths of an inch long, oval in shape, the line of the oval being slightly depressed on either side towards the posterior margin. The dorsal colouring is very strongly marked; it is a bright yellow, pale at the anterior portions, and inclined to red at the broadest part on the margin; in the centre is a yellow cross, cadmium in colour, which is spotted with a darker tone. This cross is surrounded with a dark patch very nearly black, and which in some specimens looks quite so. The eyes are a deep red. The ventral side is a little deeper in colour round the margin, but is almost colourless in the centre. The black marking which is so prominent on the dorsal side also shows well on the ventral (see Fig. 5). At the posterior end of the genital area is an angular patch of bright yellow, spotted with a deeper yellow, in the centre of which is the anal plate. The legs, palpi, and epimera are grey blue, all of which have a finely granulated surface. The first leg is about 13/300ths of an inch long, the second 1/20th, the third 4/75th, and the fourth 1/15th. The palpi (Fig. 2) shows the prickle which is one of the characteristics of this genus; it is about 4/150ths of an inch long. The ventral side in some specimens is so covered with fine downy hairs that it is almost impossible to make out the genital area. I have taken a number of females of this species, but have never yet succeeded in finding a male. The specimen from which this drawing was made was taken from a pond at Bagshot, Surrey, Sept. 24, 1894. I have had several species of *Piona* deposit their ova on the side



Piona ovata and Piona affinis

Chas. D. Soar ad nat. del.

F. Phillips Sc.

of the glass tanks in which I keep them in the same manner as I described in *Nesæa*.

Not having a male of this species, I have drawn the ventral side of *Piona affinis* ♂ (Koch), Fig. 6, thinking it would be interesting to show the difference in the structure of the epimeral plates in the male and the female; it will be noticed that the two posterior pair are very large, and nearly touch in the centre. This Hydrachnid is not so large or so beautiful as *P. ovata*; it is quite an ellipse in shape, pale blue in front, and gradually turning to yellow; the posterior margin is quite yellow; it has a yellow cross on the back surrounded with dark brown markings. Both male and female are the same colour.

In Fig. 7 I give a drawing of the nymph stage of *Piona affinis*, and which, from the position of the epimera, I take to be the nymph stage of a female. How long it remains in this stage I cannot say. I have kept it eight months in a tube and it still looks in good condition, it has plenty of colour (it is the same colour as the adults), and swims about vigorously. I have examined it at intervals, but can see no change whatever; in this stage there are only two genitals on each side in a special plate. The nymph of *Piona* can easily be recognised from the nymph of *Nesæa* by the last pair of epimeras being extended backwards to a point.

EXPLANATION OF PLATE XII.

Fig. 1.—Dorsal view of *Piona ovata*, ♀.
,, 2.—Palpus of same, showing the peg on the fourth joint.
,, 3.—Genital area of same, showing the position of genital suckers.
,, 4.—Mandible.
,, 5.—Ventral view of same.
,, 6.—Ventral view of *Piona affinis*, ♂.
,, 7.—Ventral view of *Piona affinis*, nymph.
,, 8.—First leg of *Piona ovata*, ♀.
,, 9.—Fourth leg of ditto.

Comparative Anatomy.*

THE two handsome volumes before us form a complete and very valuable Text-book of the Comparative Anatomy of the Invertebrata, in compiling which the author has endeavoured to do full justice to the numerous important results of the research of the last decades. They contain, separated as far as possible from the portions devoted to the main subject, the elements of Comparative Embryology, which will undoubtedly be welcome to many students. The Comparative Anatomy of the different animal races has been prefaced by short systematic reviews, which will prove useful to the student or systematic zoologist. The medical student will also find much valuable zoological information.

Vol. I. commences with a short introductory chapter on The Cell, followed by a Systematic Review of the PROTOZOA. Chapter II. treats of the METAZOA, and gives systematic reviews of the Zoophyta or Cœlenterata—Class 1, the Gastræadæ; Class 2, Porifera, or Sponges; and Class 3, Cnidaria. Chapter III., PLATODES. Chapter IV., VERMES. Chapter V., ARTHROPODA-ARTICULATA—First Division, Crustaceæ; Second Division, Tracheata; Class 1, Protracheata; Class 2, Antennata; Class III., Arachnoidea or Chelicerota and Tardigrada.

Vol. II. treats of the MOLLUSCA, ECHINODERMATA, and ENTEROPNEUSTA.

With a view to giving our readers a better idea of the very thorough manner in which the various subjects in these books are treated, we shall, with the publishers' permission, make a few extracts, and illustrate them with some of the blocks which they have kindly placed at our disposal. We turn, therefore, to Chap.

* "Text-Book of Comparative Anatomy." By Dr. Arnold Lang, Professor of Zoology in the University of Zurich, formerly Ritter Professor of Phylogeny in the University of Jena. With Preface to the English Translation by Prof. Dr. Ernst Haeckel, F.R.S., Director of the Zoological Institute of Jena. Translated into English by Henry M. Bernard, M.A.Cantab., and Matilda Bernard. Parts I. and II., 8vo. Part I., pp. xviii.—562; Part II., pp. xvi.—618. (London: Macmillan and Co. 1891 and 1896.) Price 17/- each net.

II., which describes the METAZOA. Here, we are told, in contradistinction to *Protista* or *Protozoa*, we have real *Animals* or *Metazoa.* "The bodies of the former consist of one single cell or of several similar cells (with the exception of *Volvox*), each of which, however, is competent to perform all vital functions (cell colony); the bodies of Metazoa, on the contrary, always consist of a number of cells, which are not all similar, but have divided among them the different forms of vital activity (cell community). The division of labour may be more or less complete, and according to it the degree of morphological complexity and of physiological perfection is determined. There are animals which are morphologically (according to structure) and physiologically (according to their vital activities) only a little raised above the Protozoan colony—*e.g.*, the *Hydra.*

"The bodies of these animals consist of only slightly different sorts of cells: digesting cells, neuro-muscular cells, stinging cells, and formative cells of eggs and spermatozoa. All these kinds of cells are, however, indispensable to the existence of the *Hydra* body; not one of them can be removed from the body without endangering its existence. The whole body is nevertheless physiologically an individual, but, as opposed to the cell, an *individual of a second; i.e., a higher order—a person.* Most animals remain at this stage of individuality. A Medusa, a Worm, a Crustacean, or a Mammal, is such an individual of the second order. In many animal divisions, however, the individuals of the second order multiply by fission or gemmation. The new individuals thus arising remain united, and together form *individuals of the third order —an animal stock.* The single individuals which collectively form such a stock may remain similar, and they may then be related to the stock in just the same way as the cell-individuals of a Protozoan colony are related to the colony; or division of labour again sets in, resulting in variety of development in body, form, and structure of the person forming the stock *(polymorphism).* Then such a stock is physiologically again an *individual of the third order.* The single persons become equivalent to instruments of this complex individual, and bear the same relation to it as the various cell elements of a single individual—*e.g.*, a *Hydra*—bear to it. As instances of animal stocks without division of labour

among the persons, we have most *Corals;* and of stocks with far-reaching division of labour and polymorphism, the *Siphonospora.*

"Even in the lowest Metazoa the cell elements are not found scattered in the body without any special arrangement. On the contrary, we find even among the simplest *Cœlenterata* that they are arranged in two epithelium-like layers, which are closely contiguous and form the wall of the body, which is pouch-shaped and provided with an opening. In keeping with the physiological activities of the various cells, the stinging cells and the neuro-muscular cells form the outer layer, while the digesting cells form the inner layer, which is turned towards the pouch cavity—*i.e.*, the gastric cavity. The reproductive cells lie protected in the deeper portions of the outer layer. These two layers, which occur in the development of all Metazoa, are called the *Ectoderm* and the *Endoderm.*"

Turning to Class III.—*Cnidaria*, sub-class *Hydrozoa*—we read:—"In all Hydrozoa an ectodermal œsophagus is wanting. The mouth leads direct into the endodermal gastric cavity. Gastral filaments are wanting. The sexual products mostly arise from the ectoderm. The sexes are generally separate."

Asexual reproduction is very common among the *Cnidaria*, side by side with sexual reproduction. Among the *Ctenophora* alone it has not been observed. In *Hydra* we find asexual reproduction by gemmation side by side with sexual reproduction in adult animals. Buds are formed by hollow outgrowths of the body-wall. These buds grow, and at the distal end a breach is formed—an oral aperture, round which the tentacles arise by means of the new outgrowths. Such buds can detach themselves from the mother-body, or they may in small numbers remain united with it for some time. In the last case small *Hydra* colonies, composed of similar individuals, arise,

In the same way, elegant and richly-branched colonies arise in most *Hydroids* (Fig. 20). The individuals of such stocks are, however, generally not similar, but, as a consequence of more or less division of labour, Dimorphism or Polymorphism takes place. We distinguish (1) sterile *nutritive persons*, which remain on the level of the *Hydroid*, and undertake the feeding of the stock, the gastric cavities of the individuals of the stock being in communi-

cation with one another; (2) *Sexual persons*, which undertake the duty of ripening the sexual products and also of planting them out and dispersing them, so that the young brood of *Hydroids* proceeding from the fertilised egg may attach themselves in new places and form new stocks. The sexual persons which are destined for a free-swimming life, and which are buds of the *Hydroid* stock, attain a structure corresponding with this manner of life; they become young *Craspedote Medusæ*, which detach themselves from the stock, swim away, and—often after longer or shorter metamorphosis—ripen the sexual products.

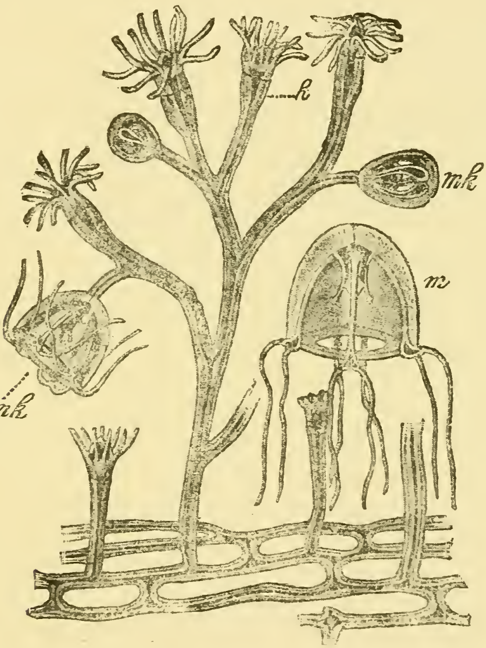


Fig. 20.—*Bougainville ramosa* (after Allman), with budding Medusæ. *h*, Nutritive polyps; *m.k.*, Medusa buds; *m.*, Detached young Medusa (*Margalis ramosa*).

Turning now towards the end of Vol. I., we come to Class *Antennata*, sub-class *Hexapoda* or *Insecta*, which is thus described:

"The body of the *Hexapoda* falls typically into three parts, quite distinct from each other: head, thorax, and hind body (abdomen). The unsegmented *head* probably originally consisted of four seg-

ments. The *thorax* is composed of three segments: *prothorax*, *mesothorax*, and *metathorax*, answering to the three anterior trunk segments of the *Myriapoda.* The typical number of segments in the hind-body is ten or eleven. The thorax and the abdomen together form the trunk, which may be compared with the trunk of the *Symphyla.* Among the *Apterygota* the *Thysanura* possess ten abdominal segments, and the *Collembola* a varying number, but always less than ten. In the *Pterygota* the number of abdominal segments in the adult animals varies, and is generally less than ten. This diminution is caused by the fusing of those segments which are connected with the genital apparatus and lie in front of the

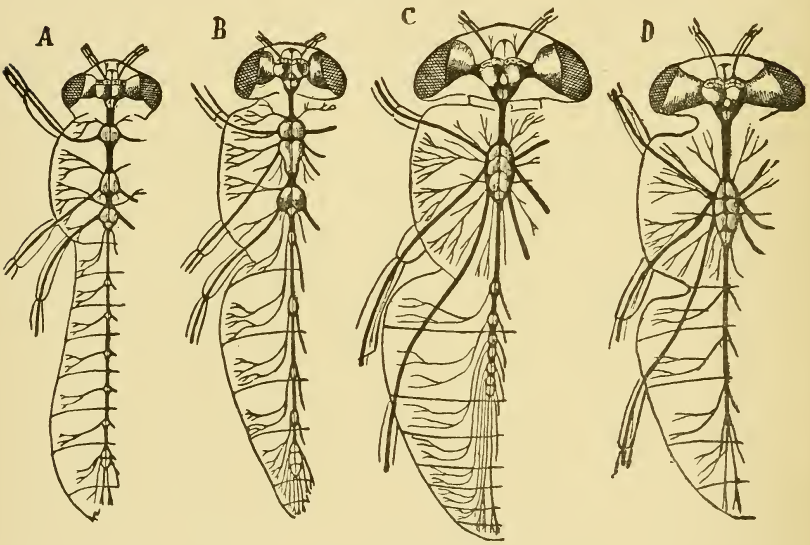


Fig. 21, *A—D.*

THE NERVOUS SYSTEMS OF FOUR SPECIES OF DIPTERA, to demonstrate their various degrees of concentration.

A, Non-concentrated nervous system of *Chironomus plumosus,* with three thoracic and six abdominal ganglionic masses.—*B*, Nervous system of *Empis stercorea,* with two thoracic and five abdominal ganglionic masses.—*C*, Nervous system of *Tabanus bovinus*, with one thoracic ganglionic mass, and the abdominal ganglia moved towards each other.—*D*, Nervous system ot *Sarcophaga carnaria.* All the ganglia of the ventral chord except the infra-œsophageal ganglion, which always remains separate, are here united into one single thoracic ganglion mass.—(After E. Brand.)

last; and, secondly, by the fusing of the anterior abdominal segments (usually only the first) with the thorax. On the other hand, in a few insects (*Macrolepidoptera*, *Diptera*, and *Rhynchota*), the last (third) thoracic segment is joined with the abdomen.

"The nervous system of the winged *Insecta* shows very great variety in its arrangement; the *Diptera* (Fig. 21, *A—D*) are particularly instructive. In no other order of insects are the extremes so great, and yet connected by such numerous intermediate stages. The series begins with the sub-order of the *Culicidæ*, *Culiciformes*, *Tipulidæ*, *Fungicolæ* (*e.g.*, *Chironomus*, *A*), which have very slightly concentrated nervous systems. The ventral chord here consists of an infra-œsophageal ganglion, three thoracic ganglia, and five to six abdominal ganglia. The last thoracic ganglion is not simple, but at least one of the anterior abdominal ganglia is fused with it. The last and largest abdominal ganglion is also not simple; it consists of several (in *Chironomus* probably two) fused ganglia. The concentration of the nervous system among the *Diptera* begins in the families of the *Empidæ*, *Asilidæ*, *Therecidæ*, *Xylophagidæ. Bibionidæ* (*e.g.*, *Empis*, *B.*), where the two anterior thoracic ganglia become fused, so that there are only two thoracic ganglia. In this respect the *Diptera* forms a contrast to other insects with only two thoracic ganglia—*e.g.*, many *Coleoptera*, *Lepidoptera*, and *Hymenoptera*. In these cases it is the posterior thoracic ganglion which consists of the two fused posterior ganglia. *Tabanus* (Fig. *C*) exhibits a nervous system, in which all the three thoracic ganglia are fused into one thoracic ganglion mass. This is the case in the families of the *Syrphidæ*, *Stratiomidæ*, and *Tabanidæ*. The abdominal ganglia show a tendency to approach each other and to fuse. Finally, the highest degree of concentration among the *Diptera* is shown in the *Muscidæ*, *Œstridæ*, and *Pupiparæ*, where all the ganglia of the ventral chord, except the infra-œsophageal ganglion, are fused into one large ganglionic mass (Fig. 21, *D*, *Sarcophaga*). From this nerve a median nerve runs towards the end of the abdomen, giving off nerves to the abdominal segments at regular intervals.

Turning now to the Second Volume, we come to a most interesting chapter on the Ontogeny of *Chiton Polii* (Mollusca), Fig. 22. The egg possesses little nutritive yolk. The segmentation is total

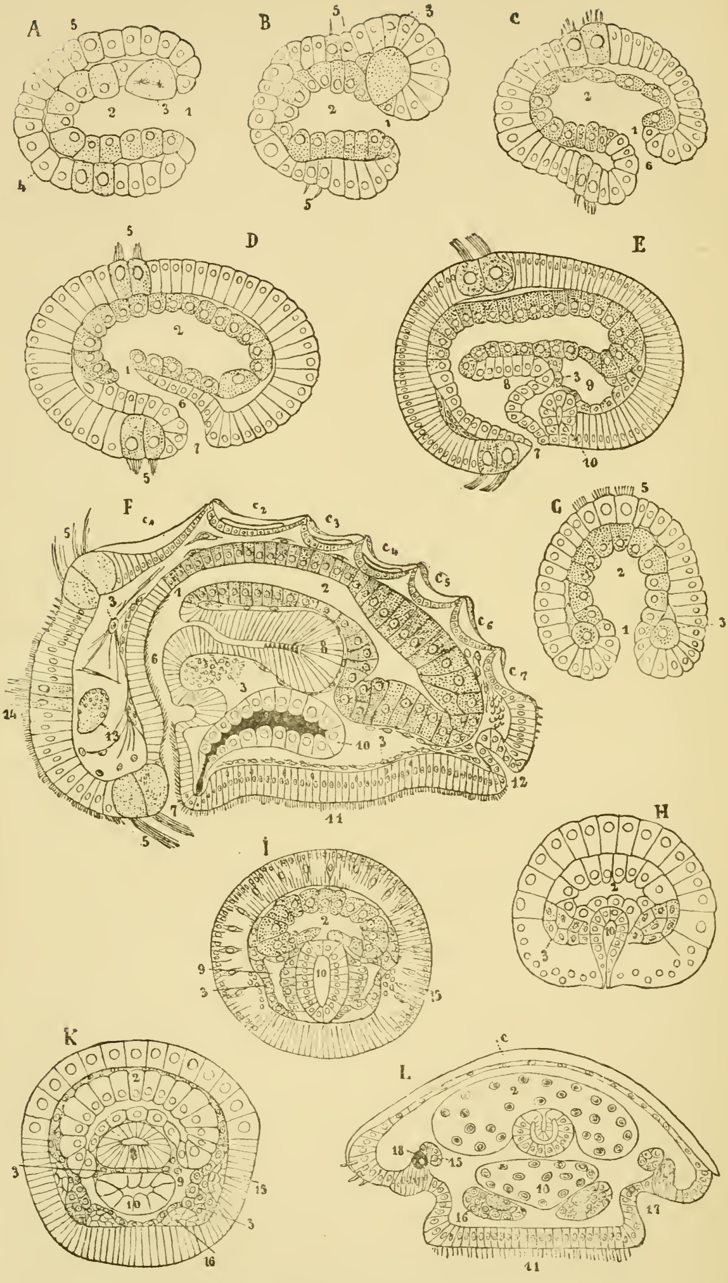


Fig. 22.—Development of Chiton Polii (see p. 283).

Fig. 22.—DEVELOPMENT OF CHITON POLII (after Kowalevsky).

A—F, Six stages in the development of the gastrula into the young Chiton, sections nearly median.—*G*, Frontal section through stage *C*, oblique, from the upper part of the velum to the blastopore.—*H*, *I*, *K*, *L*, Transverse sections of four stages of development behind the mouth. 1, Blastopore; 2, Archenteron or mid-gut; 3, mesoderm; 4, octoderm; 5, velum or preoral ciliated ring; 6, stomodæum or œsophagus; 7, mouth; 8, radular sac; 9, body cavity; 10, pedal gland, in one œsophagus; 11, foot; 12, anus with proctodæum; 13, cerebral ganglion; 14, pretrochal tuft; 15, pleurovisceral cords; 16, pedal cords; 17, mantle furrow; 18, eye; *c*, shell; *c*1—*c*7, the seven shell-plates, first formed.

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and somewhat unequal; a cœlogastrula is formed by invagination.

a, The blastopore of the gastrula larva marks its posterior end. A pair of endoform cells near the dorsal end of the blastopore are specially large. A longitudinal section shows two dorsal and two ventral ectodermal cells, with larger nuclei; these belong to a double row of cells, on which is developed the *preoral ciliated ring*, which, in Molluscs, is called the velum (Fig. 22, *A*).

(*b*) At a later stage, the blastopore appears shifted somewhat towards the ventral side, and an inward growth of ectodermal cells begins at its edge; this is the commencement of the formation of the ectodermal *stomodæum*. At the posterior and upper edge of the blastopore there is, in the figure, a cell lying between the endoderm and the ectoderm; this is, no doubt, a *mesodermal cell* (*B*)

(*c*) The larva elongates; a distinct stomodæum (embryonic œsophagus), leading through the blastopore into the archenteron, is formed by the continuous growth inward of the ectodermal cells. This organ becomes shifted still further forward along the ventral surface *(C)*.

(d) Fig. 22, *G*, is an oblique section from the anterior upper to the posterior lower point through a slightly older larva, which shows the stomodæum, and, at the sides of the blastopore, the *first mesoderm cells*. These are probably derived from the endoderm, and are symmetrically placed at the two sides of the blastopore.

(e) A median section through the next stage (*D*) shows no mesoderm cells as yet in a median place. The mouth, however, appears shifted forward along the ventral side as far as the ciliated

ring or velum, the double row of cells in the latter being very clear.

(f) Transverse section of an older stage *(H)*. The mesoderm cells have increased in number, and are arranged in two groups at the sides of the stomodæum, between the ectoderm and the endoderm.

(g) At a later stage—a longitudinal section of which is given in Fig. 22, *E*—the principal feature is a stronger development of the mesoderm, in which a space, the *body-cavity*, now appears. A bulging backward of the stomodæum forms the first rudiment of the *radular sac*. Behind the mouth, a sac-like depression is formed, evidently by the ectoderm; this has been called the *pedal gland*, although it has not as yet been discovered what becomes of it in the adult animal.

(h) When the body-cavity forms, the cells of the mesoderm become divided into two layers, the inner *visceral layer* becoming appended to the intestine, and the outer *parietal layer* to the ectoderm (*cf.* Fig. 22, *I*). In the transverse section, we see, deep down in the ectoderm, the first rudiments of the *pleurovisceral cords*. The *pedal cords* arise in the same way, and anteriorly, in the cephalic area, which is encircled by the preoral ciliated ring, the rudiments of the *supra-œsophageal central nervous system* form a neural plate—*i.e.*, as a thickening of the ectoderm, which carries a tuft of long cilia.

(i) At later stages *(F.K.L.)* the central nervous system, with the pleurovisceral and pedal cords, become detached from the ectoderm and take up their mesodermal position. The rudiments of seven shell-plates appear on the back as cuticular formations; the eighth only appears later. A posterior invagination of the ectoderm represents the rudiments of the proctodeum (the embryonic hind-gut, with the anus). The first teeth appear in the radular sac. The whole of the cephalic area and the region of the foot become covered with cilia. On the dorsal ectoderm, on the parts that are not covered by the shell-plates, the first calcareous spines appear. In the posterior part of the body, a great accumulation of mesodermal elements evidently marks the position of a formative mesodermal zone.

At this stage, the larva leaves the egg envelope and swims about freely, and, on the degeneration of the ciliated ring, sinks to

the bottom transformed into a young *Chiton*. During the last transformation, two lateral eyes appear on the anterior ventral side of the body. The development of the circulatory system, the nephridia, the genital organs, and the ctenidia has not been followed.

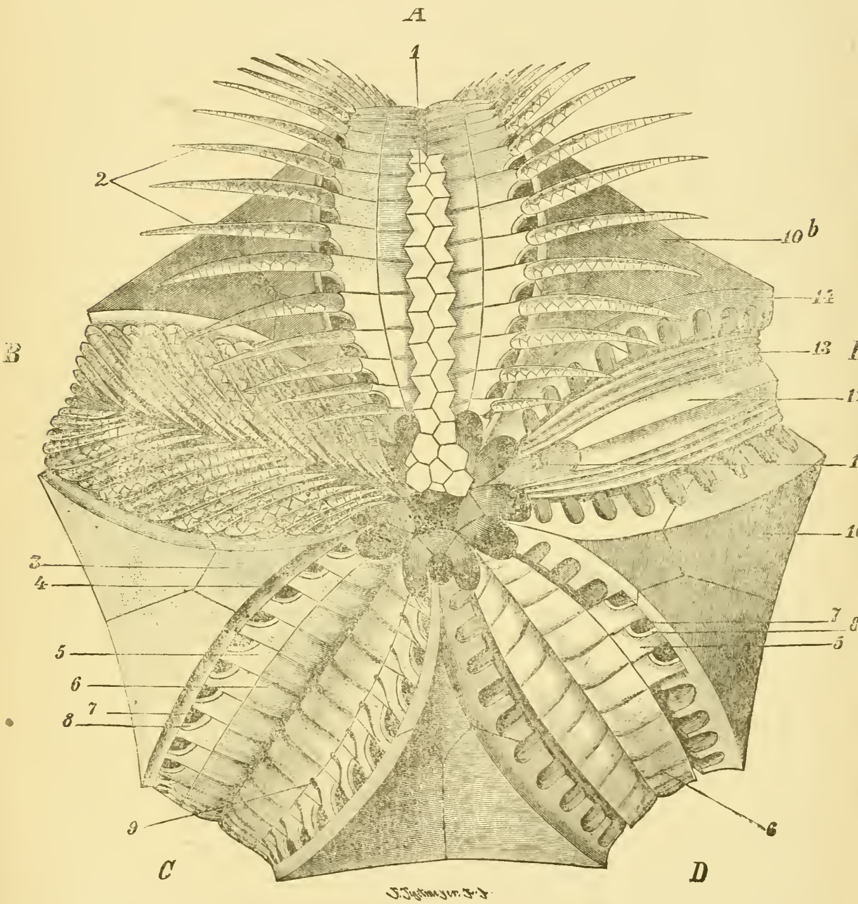


Fig. 23.—Diagram of the Organisation of a Pentremites (original).

We fear our extracts have already been too lengthy. We cannot, however, resist the pleasure of presenting our readers with Fig. 23, which shows the Ambulacral Skeleton of the *Echinodermata*.

DESCRIPTION OF FIG. 23.

A, *B*, *C*, *D*, *E*, the five ambulacra. *A*, Ambulacrum with covering-plates (1) and extended pinnulæ (2). *B*, Ambulacrum with depressed pinnulæ. *C*, Ambulacrum after removal of the pinnulæ and covering-plates. *D*, After the further removal of the side-plates and accessory side-plates (except three). *E*, After removal of the lancet plates as well. In the centre is seen the mouth with the spiracles surrounding it; in the posterior inter-radius the anus. 1, Covering-plates; 2, pinnulæ; 3, deltoid plates; 4, their sloping ambulacral edges; 5, side-plates; 6, lancet plate; 7, pores; 8, outer or accessory side pieces; 9, furrow of unknown significance on each side-plate; 10, radials (fork-plates); 11, aperture of the ambulacral canal; 12, lower lancet plate; 13, hydrospire folds.

We have been deeply interested in the perusal of these books. The illustrations, upwards of 850 in number, are all good, and the explanatory text clear and concise. Our best thanks are due to Messrs. Macmillan for the use of the electros and for permission to make the above extracts.

ARROW-POISONS.—R. Hitchcock refers to the arrow-poisons of the Ainos in a paper contributed to the report of the U.S. National Museum. According to Dr. B. Schreube, the young side-roots of *Aconitum Japonicum* are gathered in summer and dried in the shade until autumn. Such roots as contain active poison become softer, a process of fermentation appearing to take place, and after removal of their outer coating are rubbed to a pasty mass between two stones. The material is then ready to be spread upon the arrow-heads, or may be preserved, without the poison losing its activity, for five months. The results of chemical and physiological investigations of the poison by Dr. Stuart Eldridge, whilst confirming the supposition that aconite is the active ingredient, seem to indicate that other, probably inert, substances are also present in the compound. This observer states that the mass, after being mixed, is buried in the ground, and on its removal appears as a stiff, dark, reddish brown paste, which, before application to the arrows, is mixed with a certain proportion of animal fat.—*Nature*, XLVI., 475.

Significant Vestiges in Familiar Flowers.

By E. M. Hardinge, Glendale, U.S.A.

IN the very centre of the wild carrot, at the hub of its wheel of bloom, is one small, vivid crimson or purple spot. On examination, this bit of brightness proves to be a dwarfed and distorted cluster of sterile blossoms.

We get a light upon its meaning when we see, in a tropical member of the Parsley family, a little disc of red purple flowers in the heart of the large disc of white ones. In our wild carrot the rosy or purple blossoms of the central cluster set no seed, shed no pollen, and are scarcely conspicuous enough to lure insects to the fertile white blossoms which surround them. They are often so distorted and so crowded together, that the colour-spot has no symmetry, and we can scarcely believe that it has been, or could be, a disc of delicate flowers like those at the outer circumference of the wheel of bloom. Is this colour-spot a new departure or a reminiscence? The last supposition is quite as likely as the first, for Nature's changes are often eliminations.

Many common wild flowers are even now in process of change, and in them the botanist finds organs that are dwindling, or traces of organs that have almost entirely dwindled away. Thus, the members of the great Crowfoot family—the *Ranunculaceæ*—show a strong inclination to rid themselves of petals. Aconite, Columbine, and Larkspur represent the initial steps in the process. In these flowers the petals are present, but the sepals are so large and brightly coloured as to be quite sufficient lure to insect visitors. Indeed, bright and conspicuous sepals are borne by many members of the Crowfoot tribe.

The petals of such flowers are no longer necessary as insect lures. They are, in fact, "thrown out of a job," and Nature, it seems, offers them their choice of two alternatives: either they must assume some new task in the floral division of labour, or they are doomed to dwindle, in obedience to a general law of all unused organs. The petals of the Columbine are assisted in the advertising business by the sepals, which rival them in richness or delicacy of tint, so they have taken up other duties in the floral

economy, and have resolved themselves into honey-bearing spurs. This modification of the outrivalled petals is found in several members of the Crowfoot tribe. The Marsh Marigold (*Caltha palustris*) has large yellow sepals, which simulate petals and act as such, the true petals meantime being present as honey-bearing horns. In the Hellebore, also, the petals have been converted into nectaries.

The calyx of the Larkspur is so vivid in colour that the petals are not now essential to make the blossom attractive to insects. Nature, therefore, has assigned them additional duties, and only by performance of these do the petals keep their place. The two upper ones are converted into horns of plenty, stored with nectar, and the two lower are so shaped and placed as to cover the stamens and protect the pollen from thieving crawlers and rain.

In the most highly-specialised member of the family, the Field Larkspur (*Delphinum consolida*), these four petals have united into one body. "The stamens," says Sir John Lubbock, "mature one after the other, and each, as it ripens, raises its head into the small entrance to the flower, so that the proboscis of the bee, in pushing down to the nectar, can scarcely fail to jostle the anther. After shedding their pollen the stamens retire, and the stigma then comes up and occupies the place they have vacated." Flowers with their honey at the bottom of a deep spur are said by Müller to have lost the power of self-fertilisation, and the Larkspur, according to Sir John Lubbock, is utterly unable to set its seed without the visits of the humble bee.

Following the rule and custom of the Crowfoots, the four-petalled Larkspur should have a fifth petal, and it is probable that the flower once possessed one. Superseded in its decorative duties by the brilliant calyx, and finding no other work to do, this petal became useless and atrophied. It has left no trace behind, but we surmise its story from the fate which has overtaken similarly circumstanced petals in the Larkspur's next-of-kin, the Aconite.

In Aconite the process of atrophy has gone still farther. The calyx has assumed all the duties of a corolla, and the petals are reduced to two. The other three are sometimes visible as very minute rudiments among the stamens—mere reminiscences of bygone glories—and are sometimes altogether wanting. When the

calyx is corolla-like, and the superseded petals do not assume other duties, they dwindle and disappear.

In *Myosurus* they are linear; in *Isopyrum* they have become minute; and in *Zanthorhiza* they are tiny glands, not much bigger than commas. Bright and delicate sepals are the sole and sufficient adornment of the Hepatica, Trautvettaria, Anemone, Clematis, and Hydrastis. No petals at all are present in these flowers, even as rudiments. In *Cimicifuga* and *Hydrastis* the delicate and decorative sepals fall off almost immediately after the flower has expanded, showing that the last stage in this series—that of dispensing altogether with floral envelopes—is nearly reached.

It is still more nearly reached by the Rue (*Thalictrum*), which has no petals, and merely the rudiments of sepals. The *Thalictrum* produces no honey, but without stored sweets or floral envelopes it bids for and secures the attention of insects. They are lured by the conspicuous stamens, which are made to do the duty of the absent petals as well as their own.

Cimicifuga, or Bugbane, attracts insect visitors by a like device, for after its inconstant and fugitive sepals are gone, its great feathery spine of cream-white stamens is very noticeable amid the green shadows of its woodland haunts.

Atrophy of the fifth stamen is found in flowers of two orders: the Figwort family and the Bignonia family. In *Chelone* the stamen in question is present, but smaller than the others, and generally sterile—a step towards atrophy. In *Collinsia* it is a slender rudiment, and in *Scrophularia* it has dwindled to a mere scale; "a thing," says Prof. Gray, "of no use whatever to the plant, but very interesting to the botanist, since it completes the symmetry of the blossom."

In *Gratiola* and *Hysanthes*, the fifth stamen has, it seems, entirely disappeared and two more are being eliminated—are present, but sterile. Veronica has reached the goal with two stamens and no rudiments, and it gives further proof of its high organisation in its bright blue colour, in the shape of its corolla, and in the distinct drawing of its honey guides. Its poorest relations are the common mullins. Their colours, yellow and white, are, says Grant Allen, worn by "the earliest and simplest types of

existing flowers." Their flat, symmetrical, open corollas prove them to be but little specialised, and they still bear the fifth stamens which their more advanced cousins have discarded.

Most of the members of the Bignonia family are tropical, and those which are *habitués* of this soil have somewhat the air of strayed exotics. The *Bignonia carreolata* festoons the trees which fringe our southern rivers, hanging its great showy orange and crimson flowers from the topmost boughs; and more familiar members of the family are the Catalpa tree and the Trumpet Creeper of our gardens. The Bignonia and the Trumpet Creeper have each four stamens, with a very evident rudiment of a fifth. In the Catalpa the process of elimination has gone still further, and the flower bears but two perfect stamens, and two or three little white threads, which are reminiscences of the rest. All these flowers which possess stamens growing small by degrees and beautifully less are monopetalous and most of them are deep-throated. In such flowers the pollen is thriftily preserved to meet the needs of fertilisation. The stamens are, in most cases, partially protected from wind and rain, and the pollen is therefore less likely to be blown or washed away. Moreover, the monopetalous flower is comparatively safe from insect robbers. In a polypetalous flower, which keeps open house, as it were, to all comers, a crawling insect can slip in between the petals, rob the nectaries, "eat the pollen," says Grant Allen, "to his heart's content," and go out the same way he came in, dusted with pollen which probably will never be carried where it should go—to another flower of the same species. The tubular blossom is more difficult to enter and less likely to be robbed, and, in many cases, it bids for the attention of a select circle of visitors by keeping its nectar out of the reach of the vulgar mob, and accessible only to larger-winged insects. Polypetalous flowers, especially those with shallow cups, must produce enough pollen to meet Nature's requirements after many mischances have been endured, and must hence be liberally supplied with stamens. But with the union of the petals fewer stamens are needed to supply Nature's needs, and the more the blossom is tubed, the more closely, as a rule, are its anthers brought together, and the more accurately are they pressed against the body of any visiting insects.

With the tubing of the blossom, Nature shows a tendency to turn it to one side, thus preventing rain and dew from entering the flower-cup and washing the pollen away. Hence, as the petals unite and as the flower-cup deepens, there is a tendency for some of the stamens to atrophy, unless they can be so changed as to become serviceable to the flower in another capacity. This seems to have been the alternative chosen in the case of the fifth stamen of the *Pentstemon*, or Beard Tongue. This fifth stamen has evidently no present intention of effacing itself. Instead of shrinking, it seems to have grown, for it is the largest and sturdiest stamen of the group. It bears no anther, and, of course, produces no pollen, but it has evidently taken up fresh work equally useful. The two pairs of stamens are curved, so as to bring their anthers close together just under the blossom's arching upper lip, where they can scarcely fail to deposit a load of pollen upon the back of any visiting insect. But the odd one stands quite apart from the rest, and raises its head into the orifice of the corolla, just above the blossom's lower lip. This fifth stamen is clothed, especially at its tip, with fine silky hair, and it stands directly in the pathway to the nectar.

A thicket of fuzz growing on the corolla and along the pathway to the nectar is a device which has been adopted by several flowers of widely differing species. Among the orchids, *Calopogon* and *Arethusa* are bearded along the upper surface of the lower lip. *Chelone* and *Antirrhinum*, both members of the Figwort family, are bearded in the throat, and in many violets a velvety tuft grows just above the entrance to the spur, in which the honey is found. In every one of these flowers—as Sir John Lubbock has shown—the fuzz is there to prevent ants and other small pedestrians from crawling down after the honey, which the flower is trying to save for some winged insect friend. Flying insects with long proboscides make no difficulty of the vegetable fur, but it is a formidable obstacle to crawlers.

A few long scattered hairs clothe the lower lip of the *Pentstemon*, and act as additional guardians to the flower's stored sweets. But the brunt of the work of defence has been assumed by the bearded fifth stamen. It opposes a formidable obstacle to crawling thieves, and may also serve to bring the back and shoul-

ders of flying insects more closely into contact with the anthers.

By thus making itself useful, the fifth stamen of the *Pentstemon* keeps its place and its importance, while the corresponding organ in almost every other member of the Figwort family is dwindling, or aborted, or has utterly vanished away.

The Indian Turnip, or "Jack in the Pulpit" *(Arisæma triphyllum)* is in a state of transition and has nearly become a diœcious flower. Prof. Gray calls it "by abortion diœcious." The green spathe encloses a glossy spike, around the base of which will be found a group of pistils or a group of stamens. But one Jack in a baker's dozen is a case of atavism, it seems—a reminiscence, perhaps, of some bygone time when all Jacks bore both stamens and pistils. The base of its spadix is surrounded by a group of pistils, with two or three stamens above them, or by a group of stamens, with two or three pistils below them. This arrangement, occasionally referred to, as it were, by the Indian Turnip, is frequently adopted by the Green Dragon *(Arisæma Dracontium)*, and is still habitual with the near relations of the *Arisæma*, *Peltranda virginica* and *Calla palustris*. But the majority of the Indian Turnips are unisexual, and thus in this family we have a distinct series, advancing, by abortion, from a lower to a higher mode of reproduction.

The atrophy of leaves in parasites is a familiar story. Botanists count ten or twelve native plants, representing four widely different orders, which subsist, partially or entirely, on vegetable juices sucked from other plants.

The Eye-bright *(Euphrasia)* and the Yellow-rattle *(Rhinanthus)* are just entering upon a similar mode of life, following the evil example of their first cousin, the Painted Cup *(Castillea)*, which is a thorough-going root parasite. Eye-bright and Yellow-rattle are known to eke out their rations, now and then, with juices drawn from the roots of whatever grows nearest, and it is not improbable that there are other plants, as yet untouched by suspicion, which feed, partially or occasionally, upon nourishment unlawfully purloined from their neighbours. But this nefarious practice cannot remain long unsuspected, for as soon as a plant forms a habit of parasitism it begins to lose its healthy green colour, and its looks betray it.

An honest, hard-working plant, which grubs for its own living, has in stem and leaves an abundant supply of chlorophyll. To its presence the rich greens of vegetation are due, and by its means animal substances, water, and gases are converted into vegetable fibre. But the plant which takes its food, already partially digested, from some other plant, needs less chlorophyll for its support, and Nature, with wise thrift, bestows less chlorophyll upon it. Then its leaves begin to dwindle and its green colour to fade, and it is driven to more and more complete parasitism by growing unfitness for self-support.

At one end of this chapter of vegetable crime and retribution is the little Eye-bright of the New England hills, still bearing green leaves, and, to all outward appearance, living as honestly as its neighbours. At the other end is the Indian Pipe or Ghost Flower, an out-and-out root-parasite, with all its stems faded to a corpse-like pallor, and with its foliage dwindled away to small, scattered whitish scales.

The atrophy of the fifth stamen among the Figworts, accompanied as it is with more and more perfect adaptation of the flower to the winged insect, may be regarded as the atrophy of advancement. The dwindling and bleaching of the foliage of parasites is the atrophy of degeneration. The atrophy of advancement is found again if we study the growth of the fruit in some familiar trees. When a plant, in shiftless and step-motherly fashion, hands its off-spring over to those untender nurses, luck and chance, it follows that an enormous proportion of the offspring will die. But as soon as care is taken of the seed's future, making its survival probable, fewer seeds are produced. "Diminution in the number of seeds," says Grant Allen, "invariably accompanies every advance in specialisation, or every fresh forward step in appliances for more certain distribution." And "when the seeds of our fruits become atrophied," says Darwin, "the fruit itself gains largely in size and quality."

Some of our most familiar trees are even now diminishing the number of their seeds. Nature, keeping up an age-old habit, forms a large number of germs, but the trees, having adopted a newer habit, neglect most of these germs, and bring only a remnant of them to maturity. But these comparatively few off-spring

are sent into the world better nourished, better provided for, better equipped for the battle of life than they would have been, had the parent tree undertaken the maintainance of a larger number of descendants, and thus they profit by the fate of their little brothers which perished untimely.

The Horse-Chestnut blossom has a three-celled ovary, with two ovules in each cell; but the ripe Horse-Chestnut bur never holds more than three nuts, and sometimes only two, or even a solitary one. "Yet the vestiges of the seeds which have not matured," says Prof. Gray, "and of the wanting cells of the pod may always be detected in the ripe pod." The very young acorn is divided into three compartments, and each compartment has two ovules hanging from its summit. One might, therefore, expect the mature acorn to be a husk enclosing six small nuts or seeds. But, in fact, five of the cells and five of the ovules are completely obliterated in the forming fruit, which thus becomes one-celled and one-seeded, "and rarely," says Prof. Gray, "can any vestige be found of the missing parts."

The pistil of the Maple blossom has two styles, two stigmas, two ovaries, and two ovules in each ovary, but it developes into two-winged seeds. It is not unusual for atrophy to go still further, and for one of the winged seeds to stop growing very early in the season, so that the fruit turns out to be an unsymmetrical affair, with one side swelled into firmer and plumper proportions, because nourishment has been withheld from the other.

In the Acorns and Horse-Chestnuts which come to maturity, the baby-plant is supplied with a particularly rich and plentiful stock of starches on which to feed while it does its first growing, and it is protected from damp and from insect enemies by a tough, horny shell. The maple germ is also provided with sustenance for its first days of life, is wrapped in a strong covering, and is provided with a wing, so that it can fly before the autumn gales, and find fresh woods and pastures new. When the descendants of these trees are so well started in life, a large proportion of them will survive, and thus the oak, horse-chestnut, and maple families are quite as well kept up as are the families of other trees, which cast to the winds a large number of seeds less fully equipped for the battle of life.

By investigating the blossoms of the oak, horse-chestnut, and maple, we see that these trees, ages ago, bore very many seeds, which must have received but a scant provision a-piece wherewith to start themselves in life. Under these circumstances, an immense majority of the seedlings would die young, giving the parent plant the expense of putting an enormous family out into the world, and all to little purpose. To-day, evolution is teaching them "a more excellent way."

"It is a fatal habit," says Grant Allen, "to picture evolution to one's self as a closed chapter. We should think of it rather as a chapter that goes on writing itself for ever. Our fields are full of degenerate flowers which retain some memorial of their old estate, pointing backward, like the fasces of the Byzantine Emperors, to the past glories of their race in earlier times." They are also full of plants which bear somewhere about them half-obliterated traces which tell the story of their progress from a lower to a higher form of life; for the changes brought about by atrophy may be either progressive or retrogressive.

But atrophy, wherever we find its traces, proves to us one thing, that nothing retains its place in the organism unless it makes itself useful, or ornamental, or both, and that Nature tolerates no shirks; the moral of which, if moral there be, is tersely, though inelegantly, expressed in the slang phrase, "You must hustle if you want to be in it." And this is everlastingly, pitilessly true even of the smallest herb which we crush beneath our feet.

ANTS AND ORCHIDS.—According to J. H. Hart (*Nature*, LIII., 627) the presence of ants seems to be essential to the well-being of certain orchids. Whether the effects produced are directly due to ants, or to some indirect cause, has not yet been determined. The author is inclined to the opinion that the ants confer benefit on the plant by providing it with the mycelium of a fungus to cover its roots, this organism enabling it to take up food which would otherwise be unavailable. It may be that the presence of stinging-ants protects the plant; but Mr. Hart thinks it is almost certain that the fungus, which grows on the material that the ants accumulate round the roots, plays an important part in the nutrition of the plant by providing it with food material.

—*Pharmaceutical Journal.*

Selected Notes from the Note-Books of the Postal Microscopical Society.

Myrmecophelous Acari.

By E. Bostock. Plates X. and XI.

I AM circulating in the present box a number of slides containing objects collected by myself during the early part of 1891, and subsequently, in various localities, and, as I believe that none of them have been previously sent round, I trust they may prove of some interest to our members, especially as some of them have only recently been described, and possibly one or two of them may be altogether new.

They consist mainly of Myrmecophelous Acari, obtained from the nests of ants of various species in the Riviera, Corsica, and the Tyrol, and subsequently at home, as the result of various raids upon the domiciles of the unfortunate ants. They serve to illustrate to some extent how very numerous are the varieties of other creatures that are collected, protected, and nurtured by these formidable and omnivorous animals.

The question as to how they come to be found in the nests of the various ants is an interesting one, and one to which I have so far met with no satisfactory answer. Whether the ants carry them there, or whether they happen along "promiscuous like," and coming across the nests they find them comfortable abodes, and so are induced to remain, is doubtful; but one thing is quite clear, that when they *are* there, they are certainly tolerated by their formidable hosts, and this probably on account of services rendered in the shape of general scavengering or in some other manner. At the same time, it is not a little singular that most of the different forms are found associated with a particular kind of ant, and though they may not always be met with in all nests of that one kind, they are *not* met with, so far as my experience goes, outside and away from these nests, and this would hardly be the case if the Acari gathered from the surrounding neighbourhood into the ants' nests in which they happen to be found. At the same time, and be this how it may, I am inclined to the opinion that, so far

as these gamasids are concerned, it is a case of pure toleration on the part of the ants, because when their dwellings are disturbed they show no signs of anxiety on account of their messmates, whereas their flocks of aphides which may be exposed by the removal of the covering of the nests are speedily attended to and carried off to places of safety in the recesses of the same.

With the exception of occasional *Oribatidæ*, these acarids appear to belong to the family *Gamasidæ*, which is the most extensive family, perhaps, of the *Acarina*, and is considered at the same time as the most highly organised.

The family GAMASIDÆ is divided into four sub-families, viz.: the *Pteroptinæ*, which are found upon bats and allied creatures, such as the flying-fox, etc.

The *Dermanyssinæ*, parasitic upon bats and birds.

The *Gamasinæ*, which are some of them parasitic in their immature stages, whilst a larger proportion are entirely free-living, active, predatory creatures; and lastly,

Uropodinæ.—Of these also it may be remarked that many are parasitic whilst immature, for they are frequently met with attached to the legs and abdomen of insects in somewhat numerous clusters, by what was at one time supposed to be a kind of umbilical cord, and from which the family derives its name. This, again, appears to be a case of semi-parasitism only, resorted to as a means of conveyance to "fresh fields and pastures new," for no nourishment can be obtained from the hard chitinous surfaces of their temporary hosts.

The family GAMASIDÆ finds its place in the order ACARINA, having the abdomen entirely united to and fused with the cephalothorax, and in the sub-order METASTIGMATA, in which the tracheæ open at the posterior part of the body, at the base of the legs; a skeleton having for base a sternum or ventral plate. Rostrum with free, unarmed tactile palpi; mandibles chelate.

The sub-family UROPODINÆ is characterised by having a ventral plate, united all round with the dorsal plate; with excavations for the legs, and perforated in front to afford passage to the mouth-organs. The femurs of the first pair of legs are very much thickened, and in a state of rest entirely cover the mouth-opening; the dorsal plate flatly arched.

In the sub-family GAMASINÆ there are no excavations for the legs, and the ventral plate is not entirely united with the dorsal, at least in front, where a passage is left for the capitulum or tube containing the trophi. The femurs of the first pair of legs are wide apart, and are not thickened, as in the preceding sub-family.

The genus *Lælaps* is distinguished from *Gamasus* in that in the former the second pair of legs are alike in both sexes, and rarely bearing knobs or excrescences ; whilst in the latter the second pair of legs are thickened in the male, and usually provided with knobs and protuberances.

***Uropoda formicariæ** (Fig. 1) was, I believe, first discovered by Sir John Lubbock in his nests of *Lasius flavus*, and was described for him by Mr. Michael in *Ants, Bees, and Wasps*, but the species has never been figured because the specimens it was described from were mounted in balsam, and he has been waiting until he could find some fresh examples. This we have at last done in the nests of the same species of ants (*L. flavus*), during a visit to Porth Gwarra in Cornwall in October, 1892. They were met with in some numbers on the upturned stones that covered the nests of this ant, or rather upon some of them. It is a fine species, and somewhat singular in having a considerable depression in the upper hinder half of the abdomen, traversed by several transverse, thickened, chitinous ridges. A massive chitinous plate projects between the second and third pairs of legs on either side apparently for their protection.

***Uropoda coccinea** (Fig. 3).—This species was found by Mr. Michael in the summer of the same year in the nests of *Camponotus herculeaneus*, near Innsbruck, Tyrol, in considerable numbers, and was subsequently described and figured by him in a paper

* Since the above slides were circulated, a paper has been published by Mr. Michael (*Notes on the Uropodinæ*, *Journal of the R.M.S.* for June, 1894), in which he gives a list of the British species, together with a revision of the classification and nomenclature of the same. The species marked with an asterisk have their generic name altered to *Glyphopsis*, which differs from the genus *Uropoda* in having the body irregular in form, the dorsum not regularly vaulted or arched, but sculptured.

The fine species referred to above as having been left with Mr. Michael is also described and figured by him in the same No. as *Glyphopsis Bostocki*.

read before the Zoological Society in December of the same year. In the autumn of 1891 I was staying in Buxton, and there found the same species also fairly abundant in all ages and both sexes in the nests of *Formica fusca* under stones. When found alive the creature is a deep crimson and very conspicuous upon the white pupæ of the ants, a position in which it was frequently met with; but after being killed and preserved, the colour fades until it arrives at that of the present specimen. It is evidently very near in character to

***Uropoda** (lamellosa?) (Fig. 7).—Mr. Michael considers this species as doubtfully *the* "lamellosa" of Canestrini, but on comparing the drawing of the latter there is a marked difference, both in the general contour of the creature and in the sculpture of the upper surface of the abdomen, so that I am inclined to doubt that it is so. This species was also found in some of the nests of *L. flavus* in the neighbourhood of Porth Gwarra in Cornwall.

Fig. 4 (**Uropoda campomoleudina**) is found in the same nests as the above.

Fig. 5 is another **Uropoda** of doubtful species, and is met with in the nests of *F. fusca* very frequently attached to the legs of this ant, the presumption in such cases being that such individuals are about seeking another home, and so to form new colonies.

Including another very fine species of *Uropoda*—of which I only found two specimens, which I left with my friend Mr. Michael—and *Cossineæ*, also found at the same time, this makes *six* distinct and well-marked species of this genus that I met with last autumn in Cornwall, and there remain doubtless many others to reward the pains of a diligent searcher.

Læelaps equitans (Fig. 10), also found in the nests of *T. cæspitum* at the rear of Ajaccio, is a very different creature to the *Uropoda* before named, which are all very slow and inert. It runs about among the ants with the greatest activity, and in the general confusion occasioned by the disturbance of the nest is consequently difficult to capture. They might frequently be seen sitting upon the heads of some of the ants, being thus carried about by them in a temporary fashion, and disappearing with them into their subterranean galleries. This species is also figured and described in

the before-named *Journal of the Zoological Society*, together with *Lælaps lævis* and *Lælaps cuneifer.*

Lælaps lævis (Fig. 8).—The former I obtained from the nest of a ground ant, of name unknown to me. I met with it in one nest only in the woods at the back of a village called Igis, near Innsbruck, Tyrol. It occurred in some numbers, together with great quantities of a small Oribatid of the genus *Notuspis*, but of a species unknown to me.

Lælaps cuneifer (Fig. 9) came from the nests of *Camponotus herculaneus*, and was fairly plentiful in the large galleries constructed by this ant in the decaying trunks of fir-trees. With these occurred also numerous other gamasids and oribatids, and in one or two instances the curious chocolate-coloured larvæ of a species of breeze fly were comfortably ensconced in the same passages—a somewhat singular locality for a fly to make its first appearance. The colour and texture of the larva was exactly that of the galleries in which it was found.

Fig. 11 is a *Lælaps* I have been unable, so far, to identify, and is probably undescribed. It came from the nest of an ant found under stones in the olive groves at San Remo, of which I also neglected to secure specimens for identification. The acari walked leisurely about, holding their long front legs after the manner of the chelæ of chelifers.

Fig. 12 is a single specimen of a gamasid taken from the nest of a ground ant in the Aahrenthal, near to the village of Patsch. I have called it a Lælaps, but am very doubtful whether it does not belong to another genus, and I also believe it will turn out to be quite new.

Zetorchestes micronychus (Fig. 6).—To complete the quotum of slides, I have put in one containing several specimens of a very interesting Oribatid, not as yet found in this country, but which seems generally distributed on the continent—viz., *Zetorchestes mycronychus*, found amongst mosses. It is the only one in this family that is known, so far, to be gifted with the ability to jump like a flea, and is consequently difficult to capture, for as soon as it is approached with a camel-hair pencil it gives a spring and has disappeared. It will be noticed how deeply the coxæ of the last

pair of legs are inserted into the walls of the abdomen, thus giving great power of propulsion to these limbs. E. BOSTOCK.

My friend, Mr. Bostock, having granted me the privilege and pleasure of examining his slides and notes before their circulation, I feel constrained to express my gratification, and also to congratulate the P.M.S. that they have such a worker. If every member pays as much attention to them as I have done, he will not find the usual time too long for their investigation. There is so much of interest and novelty, and it is no slight privilege to have a peep at good mounts of rare, and even as yet undescribed, creatures. I wish Mr. Bostock had given a minute and detailed account of his raid on a good savage ants' nest. The idea makes me shiver. Bees are bad enough; but ants—ugh!

Uropoda formicariæ (Fig. 1) is a very fine species and well worth figuring. I know Mr. Tuffen West is no longer to be numbered amongst the members, but I hope that his mantle has fallen on some other member, who will find plenty of employment for his pencil whilst the box is with him, or I would suggest that some photographic member should do his best with these mounts.

Uropoda canestriniana is a much smaller, but equally distinct species.

Uropoda coccinia is described and figured by Mr. Michael in his paper on the "Association of Gamasids with Ants" in the *Proceedings of the Zoological Society*, Dec. 1, 1891.

The two next Uropodas are small, but very distinct and beautiful species, well worthy of being figured. One thing strikes me, and that is that all these new species are so different in form and so much smaller than the old ones, with which one is so familiar, such as *Vegetans*, *Cassideæs*, etc.

Lælaps equitans.—This beautiful mount reminds me of one of *L. hilaris*, and Koch says that these mites live a very long time in captivity, but are never still. When Koch wrote, only four species of Lælaps were known. All these were parasitic on mites, and all of them were very similar in figure. In this box we have no less than five species, all differing from those he described, and the four last of them not giving one the idea at first sight that they belonged to *Lælaps* at all. I wish I had a good English transla-

tion of Koch's work, but have never heard of one being made.

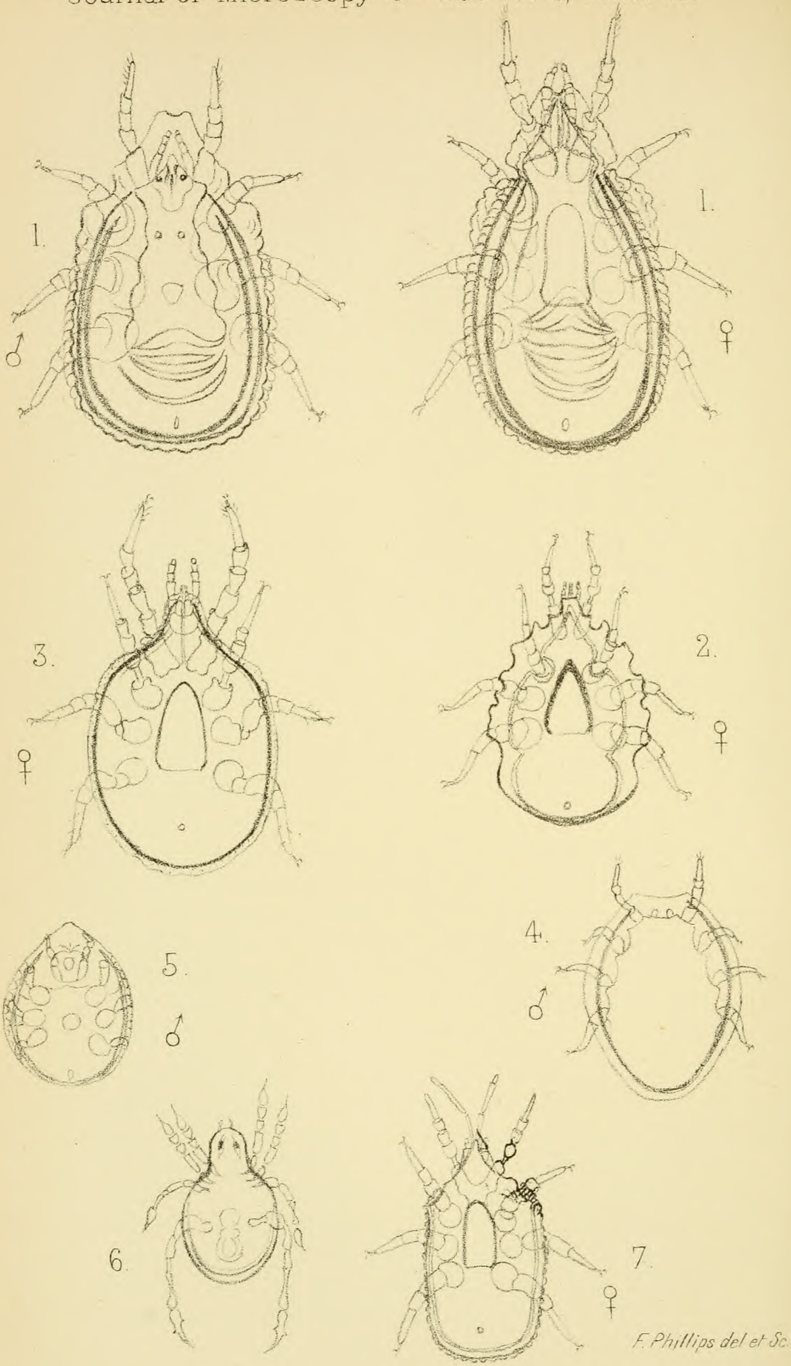
C. F. GEORGE.

Notes and criticisms from one who has not a competent knowledge of the subject are useless and unimportant. I know nothing about "Mites," and therefore shall not attempt to say anything about Mr. Bostock's valuable and interesting slides. I can only thank him for the circulation of such a carefully prepared set, so instructive and suggestive, It is not often we get any obtained by so much travel and trouble. The whole subject of the various lodgers in ants' nests deserves investigation by some competent naturalist. It is one on which Darwin might have written nobly. Sir John Lubbock speaks of certain beetles which live in ants' nests, and suggests, if I remember right, that they may be objects of worship! I could wish Mr. Bostock had said something more about the *structure* of Acari, and I should like to know how he preserved them before mounting. Are they put when caught at once into turpentine or acetic acid? I have been looking at what Nicholson says about Mites. Does he not confuse Mites with Ticks? Are not mites near akin to spiders—creatures with eight legs? Are not ticks *insects* with six legs (like the sheep tick)—degenerate flies, in fact, which have lost their wings?

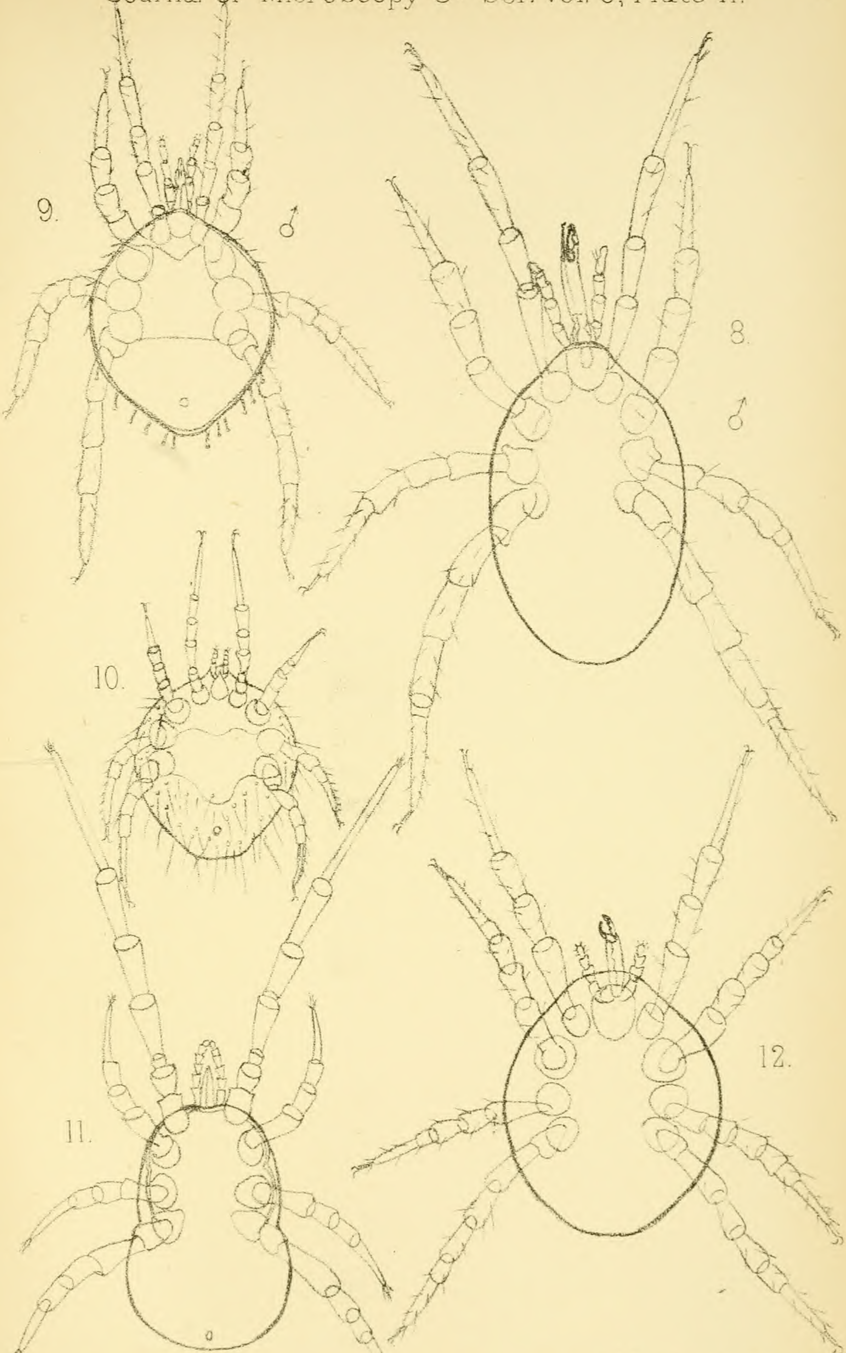
R. S. PATTRICK.

I am grateful for the privilege of examining these notes, and have found them of great assistance in gaining a little knowledge about these creatures. I should like to know more definitely than I have been able to gather from the notes the functions of the Acari in the nests, and also how such objects are caught and preserved, as I can hardly imagine them so plentiful as to be found upon every ant that may be caught. W. S. INGRAM.

I am glad to find the accompanying slides have proved of interest to some of our members, and also that they have borne their travels so satisfactorily. Before starting them again, I take the opportunity to reply to the Rev. R. S. Pattrick's query as to how they are preserved (*i.e.*, the acari) before mounting. My general plan when practicable is to place them in a saucer of water, then kill them in boiling water, from which they are transferred to slightly dilute acetic acid. This keeps them in fair condition for subsequent treatment for some time.



Myrmecophilous Acari.



Myrmecophilous Acari

Ticks.—Nicholson is quite correct in placing Ticks among the Acarina, of which order they constitute a considerable family, under the title *Ixodidæ*, which includes *Argus* also. The Sheep-tick (so called) is not a tick at all, but a degraded fly. It has only six legs, in common with other *insects*, whereas the Ticks and remaining families of the *Acarina* have all eight legs, barring certain degraded forms. I think, however, the main point of difference between the different families have been more than once pointed out in our Note-books by myself, and it seems superfluous to repeat these matters with each fresh box.

I am afraid I cannot enlighten Mr. Ingram more definitely as to the functions of the Acari that avail themselves of the shelter of the nests of ants, beyond stating that they are probably induced to remain there because of the food picked up amongst their hosts. Again, they probably act as scavengers; but I feel doubtful as to whether any more intimate connection exists, or that they are there on any other principle than that of toleration. It is true, however, that they are not found indiscriminately in *all* ants' nests, and that certain Acari appear to be associated with certain kinds of ants.

The thanks of the Society are due to Miss F. Phillips for her nicely-executed drawings. E. BOSTOCK.

EXPLANATION OF PLATES X. AND XI.

PLATE X.

Fig. 1, 1.—*Uropoda formicariæ*, ♂ and ♀.
,, 2.—*U. canestriniana*, ♀, × 50.
,, 3.—*U. coccinea*, ♀, × 50.
,, 4. *U.* (? sp.), ♂, from nests of *F. flava*.
,, 5. *U.* (? sp.), ♂, ditto.
,, 6.—*Zeterchestes micronychus*, × 50.

PLATE XI.

,, 7.—*Uropoda laminosa* (? sp.), ♀, × 50.
,, 8.—*Lælaps lævis*, ♂, × 50.
,, 9.—*L. cunifer*, ♂, × 50.
,, 10.—*L. equitans*, × 50.
,, 11.—*L.* — (? sp.).
,, 12.—*L.* — (? sp.).

Coniferous Wood from Coal Measures (vert. sec.).—Traces of the glandular tissue (peculiar to the cone-bearing trees) can be found in many parts. But the principal interest in the specimen lies in the fact, that while in the condition of ordinary wood, *it was perforated by the larva of some insect, and that the perforations have been left filled with excreta*, just as we should find a bit of worm-eaten wood of the present day. W. PUMPHREY.

No doubt the black, roundish bodies in the cavities are the remains (carbonised) of the animal which burrowed, but it seems to me doubtful if they are excrement. If so, the animal produced a bulk about equal to himself, and the several pellets are large in proportion to the size of the larva, which would not have been larger than the cavity it occupied; and if these are all excrementitious, what has become of the animal itself? Possibly I may be answered that the animal has come to maturity and crawled out, leaving its excrement, but in that case we may suppose the latter would have been at one end of the cavity and not distributed all through it. G. D. BROWN.

I do not think the above an improvement of Mr. Pumphrey's explanation of his slide. From observations of similar burrows in wood, I am convinced that those in the slide are, as Mr. P. says, filled with excreta, just as we should find a piece of insect-eaten wood at the present day.

The rounded bodies are not remains of the animal itself, but its excreta, which are likely enough to fill the burrow. The larva can only progress by passing every particle of the excavated material through its intestines. A. HAMMOND.

Cyclostoma elegans, Palate of.—This small snail is common in most chalky districts; its shell is closed by an operculum. The palate contains seven rows of teeth, and is different from that of the other land-snails. M. FARHALL.

Cyclops quadricornis.—I direct particular attention to the three eyes or lenses. I protest against the word facets, as applied to them. It will be found that the two upper eyes are directed respectively to the right and left, whilst the under one is straightforward, though probably it may be used to view objects immediately below it approaching the mouth.

The eyes should be examined in various lights; arrange the condenser properly, and the eyes will shine like opals. How is it these eyes are so much more brilliant than those of insects?

R. K. CORSER.

Ditto.—I have not minutely examined the eye of cyclops, but comparing Mr. Corser's slide with my own observations on *Diaptomus Castor*, I am certainly inclined to support its triple nature—*i.e.*, I think it consists of three crystalline lenses (not facets, for facets are cuticular structures, whereas the lenses are derived from the epidermis). I think it highly probable that the structure of the eye in *Cyclops* and *Diaptomus* is essentially similar to that of *Daphnia*, differing mainly in the fewness of the lenses.

A. HAMMOND.

Cyclops.—In the new edition of the *Micrographic Dictionary*, Cyclops is said to have a *single* central eye; but Huxley, in his *Invertebrata*, says there are *two* simple eyes together within the carapace. Nowhere can I find mention of three ocelli.

T. GOUGH.

Ditto.—Carpenter states that "this genus receives its name from possessing only a single eye, or, rather, *a single cluster of ocelli.* The slide enclosed in this box certainly shows three ocelli, whatever may have been written to the contrary. From Mr. Gough's remarks, it seems that one noted scientific man alleges that this Crustacean has *two simple eyes.* I wonder what he would say of this slide if it came under his own eye. Gosse, in his *Evenings at the Microscope* (1st edit., p. 216), states that "the eye of Cyclops is elaborately constructed; for it consists of a *number* of (not very large) *simple eyes* placed beneath a common glassy cornea. Several muscle-bands are attached to this *compound organ* of vision, and are arranged so as to form a cone, of which the eye is the base; these give the eye a movement of rotation upon its centre, which may be distinctly seen."

I am inclined to think that previous observers were not so much *in error* as Mr. Corser seems to imply, but that they were not sufficiently *precise.* They noted that the eye of the creature was situated *in a single spot*—hence the allusion to the fabled monsters of classic history. More modern observers, as quoted

above, have asserted what is no doubt the true state of the case. The so-called *single eye* is really a *cluster of ocelli*. R. H. MOORE.

Calathus cisteloides.—This beetle is figured in Rev. J. G. Wood's *Common British Beetles* and named *C. cisteloides*, and is described at p. 34 as follows:—

"The length of this insect is rather under half-an-inch. It is one of the dull-coloured species, as are indeed almost though not all beetles which live in dark retreats and only venture into the open air at night. It is almost entirely black, but the basal joint of the antennæ and the legs are red. Sometimes even the legs partake of the general black hue of the body.

The disc of the thorax is extremely wrinkled, and there is a large oval impression on either side of the base. It is narrower in front than at the base. The head is very smooth and convex behind, and has a small furrow on either side between the antennæ. This is one of the wingless genera, the second or membranous pair of wings being undeveloped." H. W. LETT.

Coleus, Leaf and Glands.—The red beads on the leaf of Coleus are the essential oil-glands. Similar appendages will be found on the leaves of the common Myrtle, the Mints, Sweet Briar, Eucalyptus, and Garden Lavender; all of which yield a perfume more or less readily when bruised or crushed, which ruptures the little vessels and the essential oil escapes. H. W. LETT.

The slides illustrating the essential-oil glands in the leaves of plants are most interesting. Some species of Citrus have them as fully developed as *Hypericum perforatum*, about which latter plant, by the way, an old legend relates that the minute holes are formed by the devil with his needle. E. E. JARRETT.

Coal Section.—The slide so marked is incorrectly named, but the error is by no means uncommon, as almost all dealers supply similar sections under the same name. Still, as the substance sectioned is *Lignite*, the title is partly correct, as it is the coal of the *Tertiary period*. It contains much more bitumen than our own coal of the carboniferous period, is also much softer, so much so that it can be easily cut with a knife. It has a dull, earthy appearance, and has no "joints" in it.

It is not at all wonderful that under the microscope it should show woody structure, as fragments of wood, and large ones too, are abundant in it, and so little decomposed some of them are, that they require to be cut with a hatchet in some cases. At least, such was the case at a mine which I visited this summer at Dürnten, near the lake of Zurich, Switzerland. An interesting discussion on the subject of making "Coal-Sections" appeared in *Science Gossip* in 1882, beginning in the April No., the gist of which is that sections of house-coal are *almost* impossible to make, and even when made show very little structure. The instructions for making Coal-Sections, as given in the *Micro. Dictionary*, are perfectly useless as applied to house-coal; it is simply wasted time to try to follow them. Some persons, however, *can* prepare them by a process of their own. I obtained one from Herr Heinrich Hensoldt, 7 Machell Road, London, S.E., a very skilful preparer.

JAMES C. CHRISTIE.

Reviews.

A TEXT-BOOK OF PATHOGENIC BACTERIA for Students of Medicine and Physicians. By Joseph McFarland, M.D. Royal 8vo, pp. 359. (London: H. Kimpton, 1896.) Price 12/- net.

In this handsome volume the author gives a concise account of the technical procedures necessary for the study of bacteriology, a brief description of the life-history of the important pathogenic bacteria, and a sufficient description of the pathological lesions accompanying the micro-orgismal invasions to give an idea of the origin of symptoms and the cause of death. In the first section of the book are chapters on the Biology, Methods of Observing, and the Cultivation of Bacteria, etc. etc.; the second section treats of Specific Diseases and their Bacteria. There is one coloured plate and 113 good illustrations in the text.

WAYSIDE AND WOODLAND BLOSSOMS: A Pocket-Guide to British Wild Flowers for Country Ramblers. First Series. By Edward Step. Second edition, size 6½ by 3½ inches; pp. xiii.—172. (London: F. Warne and Co. 1896.) Price 7/6.

A very useful pocket companion for the country rambler, its purpose being to assist a very large class of persons who possess a strong love of flowers, but to whom the ordinary "Floras" are books written in an unknown tongue. It contains coloured figures of 156 species, black-and-white plates of 22 species, and clear descriptions of 400 species.

HOW PLANTS LIVE AND WORK: A Simple Introduction to Real Life in the Plant World. Based on Lessons originally given to Country Children. By Eleanor Hughes-Gibb. Cr. 8vo, pp. xii.—115. (London: C. Griffen and Co. 1896.) Price 2/6.

The instructions here given, which take the form of talks with young children, are in language so plain as to be understood by all old enough to appreciate a lecture on botany, and sufficiently interesting to secure their attention.

DIE NATURLICHEN PFLANZENFAMILIEN. By A. Engler. Parts 131 to 135. (London: Williams and Norgate. Leipzig: Wilhelm Engelmann. 1896.)

These parts contain the Rutaceæ, Simarubaceæ, and Burseraceæ, by A. Engler; Labiateæ, by J. Briquet; and Meliaceæ, by H. Harms. In these numbers there are 110 illustrations, comprising 1082 figures and 1 fine photogravure plate. The price of these numbers is 3/-, or by subscription 1/6.

A HANDBOOK TO THE BIRDS OF GREAT BRITAIN. Vol. III. By R. Bowdler Sharpe, Ll.D. Cr. 8vo, pp. xiii.—338. (London: W. H. Allen and Co. 1896.) Price 6/-

This vol. of Allen's Naturalists' Library continues the description of the order Anseriformes, and further describes the following orders:—Ardeiformes, Gruiformes, and Charadriiformes. It contains also 35 coloured plates.

THE EVOLUTION OF BIRD-SONG, with Observations on the Influence of Heredity and Imitation. By Charles A. Witchell. Cr. 8vo, pp. x.—253. (London: A. and C. Black. 1896.) Price 5/-

Mr. Witchell, author of "The Fauna of Gloucestershire," has given the bird-lover much to interest him. The various chapters treat of The Origin of the Voice; Alarm-Notes; The Influence of Combat; The Call-Note; The Simplest Songs; The Influence of Heredity in the Perpetuation of the Cries of Birds, etc. etc.; and in the Appendix we have Transcripts of Music sung by Blackbirds, Thrushes, and Skylarks.

CHATS ABOUT BRITISH BIRDS. By J. W. Tutt, F.E.S. Cr. 8vo, pp. 209. (London: George Gill and Sons.) Price 2/6.

In the sixteen chapters into which the book is divided, Mr. Tutt gives us a lot of most interesting and instructive reading. Every page is full of information. There are also nearly 100 full-page and other illustrations, and the book is very nicely got up.

OUR COUNTRY'S BUTTERFLIES AND MOTHS and How to Know Them: A Guide to the Lepidoptera of Great Britain. By W. J. Gordon. Cr. 8vo, pp. viii.—150. (London: Day and Son, and Simpkin, Marshall, Hamilton, and Kent.) Price 6/-

This is an admirable book for the identification of Butterflies and Moths, its object being to enable the collector to name the specimens he may meet with, so that he may refer more readily to the fuller descriptions in the many other works on the subject. It contains coloured plates giving 1,000 examples of Lepidoptera, by H. Lynn, and many original diagrams. No young collector should be without this book.

A HANDBOOK TO THE ORDER LEPIDOPTERA. By W. F. Kirby, F.L.S., F.Ent.S., etc. Butterflies, Vol. 2. Crown 8vo, pp. xxiii.—332. (London: W. H. Allen and Co. 1896.) Price 6/-

This vol. of "Allen's Naturalists' Library" completes the survey of the Butterflies, with the exception of the *Hesperiidæ*, which will be published in the third volume. In the present volume are 31 coloured plates, giving full-sized representations of some 70 or 80 species. Many interesting observations on habits, etc., will be found scattered through the book.

THE ROYAL NATURAL HISTORY. Edited by Richard Lydekker, B.A., F.R.S. (London: F. Warne and Co.) Price 1/- net.

Part 31, the last part of this fine work which has reached us, is the first part of the sixth and last volume. The Natural History of the INSECTA is commenced in this part, in which is described the Ants, Bees, and Wasps (Hymenoptera), Flies and Fleas (Diptera), and Butterflies and Moths (Lepidoptera). Each part contains a number of good illustrations, besides two plain and two coloured plates.

NATURE'S WONDERS. By Edith Carrington. Cr. 8vo, pp. 216. (London: Geo. Bell and Son. 1896.) Price 1/-

An interesting account is here given of Wonders of the Air, Wonders by the Wayside, Wonders of the Pond, Everyday Wonders, and Wonders of Feeling. This is one of the series of " 'Animal Life' Readers" arranged for the various standards, the volume before us being for Standard V. All young people must like to read these books.

THE AQUARIUM: Its Inhabitants, Structure, and Management. By J. E. Taylor, Ph.D., F.L.S., F.G.S., etc. Sixth edition. Crown 8vo, pp. xv.—316. (London: W. H. Allen and Co. 1896.) Price 3/6.

Those interested in the life-histories of Aquatic Animals will do well to read this little book, a sixth edition of which is now before us. Amongst its various chapters will be found instructions for Constructing both Marine and Fresh-water Aquaria, and how to stock them and keep them in order. There are 239 illustrations.

ARTISTIC AND SCIENTIFIC TAXIDERMY AND MODELLING: A Manual of Instruction in the Methods of Preserving and Reproducing the Correct Form of all Natural Objects, including a Chapter on the Modelling of Foliage. By Montague Browne, F.G.S., F.Z.S., etc. Fscap. 4to, pp. xii.—463. (London: A. and C. Black. 1896.) Price 21/-

This important work treats the subject of Taxidermy and Modelling in a very thorough and up-to-date manner, and although many of the processes described are somewhat advanced and necessarily technical, yet, as the old methods have been re-described, corrected, and have had new light thrown upon them, the learner is easily led from the known to the unknown, the stages being so defined that he need not be alarmed at the magnitude of the task before him. There are 22 plates and 11 illustrations printed in the text. The volume is a handsome one, printed on stout paper, with top edge gilt.

NATURE'S BYEPATHS: A Series of Recreative Papers in Natural History. By J. E. Taylor, Ph.D., F.L.S., F.G.S., etc. Sixth edition. Cr. 8vo, pp. viii.—408. (London: W. H. Allen and Co. 1896.) 3/6.

This is one of the most interesting books written by Dr. Taylor, the late editor of *Science Gossip*. The series of 27 papers are on various subjects—*e.g.*, Subterranean Mountains; Soils, their Origin, Renovation, and Decay; A Naturalist on the Tramp; The Geological Dispersion of Animals and Plants; Aquatic Engineers; Vegetable Parasites; etc. etc.

MATHEMATICAL QUESTIONS AND SOLUTIONS from the *Educational Times*; with many additional Papers and Solutions and an Appendix. Edited by W. J. C. Miller, B.A. Vol. LXIV. 8vo, pp. 128. (London: Francis Hodgson. 1896.) Price 6/6; to subscribers, 5/-

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INTERMEDIATE SCIENCE. Mixed Mathematics Papers, being the Questions set at the University of London from 1877 to 1895. Crown 8vo. (London: W. B. Clive.) Price 2/6.

THE INTERMEDIATE ALGEBRA, based on the *Algebra* of Radhakrishnan. By William Briggs, M.A., F.C.S., F.R.A.S., and G. H. Bryan. Sc.D., F.R.S., etc. Cr. 8vo, pp. vii.—375. (London: W. B. Clive. 1896.) Price 3/6.

We learn by the Preface that Prof. Radhakrishnan's book is the outcome of the intelligent digestion of the best English authorities, particularly of De Morgan, Clifford, and Chrystal, and in the book before us the Indian work has been subjected to numerous alterations and modifications, and considerable additions have been made (notably, Logarithms, Interest, and Annuities) to render it more suitable to the wants of English students. These last-named chapters are entirely new; a new method is introduced of treating annuities *without* employing the formula for a geometrical progression.

A NEW ENGLISH DICTIONARY on Historical Principles, edited by Dr. James A. H. Murray. FIELD—FISH. By Henry Bradley, Hon. M.A. Oxon. (Oxford: The Clarendon Press. London: H. Frowde. April, 1896.) Price 2/6.

The present section is concerned with words that are among the oldest and most frequently used in the language. This part contains 766 main words, of which 586 are current and native or fully naturalised, and 161 (or 27·4 per cent.) are obsolete. There are also 553 combinations and 97 subordinate, making 1416 in this section.

THE ORACLE ENCYCLOPÆDIA, containing the most accurate information in the most readable form. (London: George Newnes.)

Part 19 of this work commences the fourth volume. Commencing with London, it carries on to the word MEDICI. This part consists of 120 pages. There are many illustrations.

A POPULAR HANDBOOK AND ATLAS OF ASTRONOMY: Designed as a Complete Guide to a Knowledge of the Heavenly Bodies, and as an Aid to those possessing Telescopes. By William Peck, F.R.S.E., F.R.A.S., etc. Large 4to, pp. xii.—176. (London and Edinburgh: Gall and Inglis. 1890.) Price 21/-

In this fine work the various subjects are described in a popular manner, complete and accurate information being at the same time given in the principal departments of modern astronomy. The aim of the author has been to supply the knowledge that is required by every fairly-well educated individual—viz., to give a clear, accurate, and popular account of the nature of the various heavenly bodies and their position in the universe.

In the first chapter, in a condensed form, is presented the Author's investigation as to the origin of the Constellations; these are the outcome of many years' study. The principal subjects discussed in the various chapters are arranged under various heads

We believe the Atlas will be found to be of the greatest assistance to all who are desirous of obtaining an accurate knowledge of the sidereal heavens, and have great confidence in recommending it to our readers. There are 45 large plates, maps, etc., and many illustrations, diagrams, etc.

HISTORICAL AND FUTURE ECLIPSES, with Notes on Planets, Double Stars, and other Celestial Matters. By Rev. S. J. Johnson, M.A., F.R.A.S. Crown 8vo, pp. viii.—178. (London: James Parker. 1896.)

We have in the first part of this book a brief account of some very early Chinese eclipses, and of the most ancient eclipses of which we have clear record, eclipses in the Christian era, and a long list of future eclipses extending to A.D. 2491, with diagrams; Part 2 contains interesting notes on Planets, Double Stars, and other celestial matters.

THE STORY OF A PIECE OF COAL: What it is, Whence it comes, and Whither it goes. By Edward A. Martin. Fcap. 8vo, pp. 179. (London: G. Newnes. 1896.) Price 1/-

This volume of the "Library of Useful Stories" brings together the principal facts and wonders connected with a piece of coal into the focus of a few pages, where side by side will be found the record of its vegetable and mineral history, its discovery and early use, its bearings on the great Fog problem, and its useful illuminating gas and oils. These little books are deserving of much praise.

THE STORY OF ELECTRICITY. By John Munro. Fcap. 8vo, pp. 194. (London: George Newnes. 1896.)

This is another volume of Sir George Newnes' very capital "Library of Useful Stories." It describes in very plain language the Electricity of Friction. of Chemistry, of Heat, and of Magnetism; Electrolysis; the Telegraph and Telephone; Electric Light and Heat: Electric Power; and the Minor Uses of Electricity. There are 100 illustrations. A useful list of books relating to Electricity, with the published price of each, is given. We trust this series of story-books may be greatly extended.

THE PHOTOGRAPHIC REFERENCE-BOOK: Hints, Information, and Methods concerning all kinds of Photographic Work and Recreation. Compiled by W. A. Watts, M.A., under the direction of Henry Sturmey, editor of *Photography*. 8vo, pp. 300. (London: Iliffe and Son.)

A very large amount of information is contained in the 300 pages of this book, which is essentially a worker's handbook, the keynote of the volume being *how to do everything* in connection with photography.

THE YEAR-BOOK OF PHOTOGRAPHY and Amateur's Holiday Guide for 1896. Cr. 8vo, pp. (about) 400, or counting Advertisements 628. (London: *The Photographic News*.) Price 1/-

The various sections into which this book is divided treat of Progress and Practice, Facts and Formulæ, The Amateur's Holiday Guide, Lanterns and their Accessories, and Novelties of the Year. It is a thoroughly good shilling's worth, well illustrated by plates and smaller illustrations.

THE GOSPEL OF BUDDHA according to Old Records, told by Paul Carus. Fourth edition. Cr. 8vo, pp. xvi.—275. (Chicago: The Open Court Publishing Co. 1896.)

Dr. Carus tells us that the bulk of the contents of this book is derived from the old Buddhist canon. Most of the passages are literally copied from translations of the original texts. Buddhism appears to be split up into innumerable sects, but the present book follows none of the sectarian doctrines. It takes an ideal position, upon which all true Buddhists may stand as upon common ground.

BLACK'S GUIDE TO THE ENGLISH LAKES. Edited by A. R. Hope Moncrieff. Crown 8vo, pp. x.—223. (London: A. and C. Black. 1896.) Price 3/6.

This edition (the twenty-second) will be found to be practically a new work, it having been re-written and re-cast. It is divided into the following sections, viz.—Windermere, Ullswater, Central, Keswick, and Coast sections. There is a large map of the Lake District in pocket at the end of the book; also, a number of Section and District maps.

PLEASURE-CYCLING, by F. T. Bidlake; with Helps to Riders, by Sennocke. Cr. 8vo, pp. 32. (London: Iliffe and Son. 1896.) Price 1/-

In these 32 pages the author finds something to say on the pleasure and healthy exercise of cycling. He gives hints to riders on choosing a machine, learning to ride, etc.

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THE PRACTICE OF COOKERY AND PASTRY adapted to the business of every-day life. By D. Williamson. Twenty-first edition. Cr. 8vo, pp. xvi.—359. (Edinburgh: Andrew Elliot. 1896.)

This little book contains a large number of practical and useful receipts on every conceivable subject in relation to cookery, from Soups to Pickles and Preserves. The author appears to have taken pains to make his directions as clear and distinct as possible, both as regards quantity of ingredients and time required for cooking.

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Messrs. Cassell and Co. have sent us the following:—

CASSELL'S CONCISE CYCLOPÆDIA. Parts I., II., III. 6d. each.

Commencing with A, these parts carry to Daddy Long-Legs, for a description of which the reader is referred to Crane-Fly. The descriptions are short, concise, and to the purpose. There are two plates and a number of smaller illustrations in each part.

CASSELL'S NATURAL HISTORY, Parts 1, 2, and 3. Edited by P. Martin Duncan, M.B.Lond., F.R.S., F.G.S., etc. Price 6d. each.

We are pleased to know that Messrs. Cassell are publishing a remarkably cheap edition of their Natural History. The numbers before us give the natural history of the Apes and Monkeys and of the Lemurs, by Prof. Martin. Each part, consisting of 96 pages, contains a great number of illustrations and several full-sized plates; with the first part is also given an extra-large plate.

BRITISH BATTLES of the Nineteenth Century. Price 7d.

This interesting serial has now reached its 16th part, which contains accounts of The Turks before Alexinatz; The Gurkha War; Bayleu; Villersexel; Canadians in the Field; Three Features of the War of 1812; The Fight for Valparaiso, 1891; and Inkermann. There are some good illustrations.

EUROPEAN BUTTERFLIES AND MOTHS (price 6d.) has now reached the 25th part. Each contains a large coloured plate and eight pages of descriptive letterpress.

SCIENCE FOR ALL. Edited by Robt. Brown, M.A., Ph.D., F.L.S., F.R.G.S. Price 6d.

Contains most interesting papers on every department of science. Part 7 (last received) has chapters on the following subjects:—The History of a Hen's Egg; Growth; The Magic-Lantern; A Primrose; A Cannon Shot; Why the Rain Falls; A Story of a Volcano as told in History; Can Science Conquer Rust?; How the Airs were discovered; What is Work?; The Hand; How Glaciers move; Dust; A Piece of Rock Salt; and Protective Mimicry in Animals. Each part contains 96 pages.

THE STORY OF THE HEAVENS. By Sir R. Ball. Price 6d.

In Part 9 the description of Uranus is concluded and that of Neptune commenced. A fine plate accompanies each part.

CHUMS. 6d. monthly.

Two new serials are commenced in the June part. Prizes are offered by the editor for which our young friends would do well to compete, even if they are unsuccessful.

British Hydrachnidæ.

By Charles D. Soar. Part VI. Plate XVI.

Genus VI.—*Diplodontus* (Duges).

In the present paper we propose to direct attention to a genus which differs considerably from that last described.

1834.—*Diplodontus*, Duges, "Remarques sur la famile des Hydrachnes" in *Annales des Sciences. Nat.*, Tom. I., p. 144.

Body soft-skinned; legs well-supplied with swimming hairs; claws to all the tarsi. Epimera in four groups. Palpus short and chelate. Eyes four, two on the Dorsal and two on the Ventral side, near the margin of body. The genital plates on each side of the genital fissure are covered with numerous genital pores.

This genus differs very much from the last which we considered. At present I only know of one species in England, although I have taken three varieties of it in as many different localities. This Hydrachnid is very common; I have secured as many as forty specimens in one day's collecting. I consider there are three varieties, because, although all are identical in structure, the colouring of the three varieties is distinctly different.

Diplodontus despiciens (Mull.).

Bibliography.

1781.—*Hydrachna despiciens*, Müller, *Hydrachnæ*, p. 58, Plate VI., Fig. 8.

1834.—*Diplodontus filipes*, Duges, "Remarques sur la famile des Hydrachnes," in *Annales des Sciences*, p. 158, Plate X., Figs. 1—4.

1854.—*Diplodontus filipes*, Bruzelius, *Beskr. ö. Hydrachn. som. forek. i. skane.*, p. 44, Tab. IV., Figs. 9—12.

1878.—*Diplodontus filipes*, Krendowsky, *Die Metamorphose Hydrachnidæ*, p. 8, Plate I., Figs. 3—4.

1880.—*Diplodontus filipes*, Newman, *Sveriges Hydrachnides*, p. 108, Tab. XIII., Fig. 3.

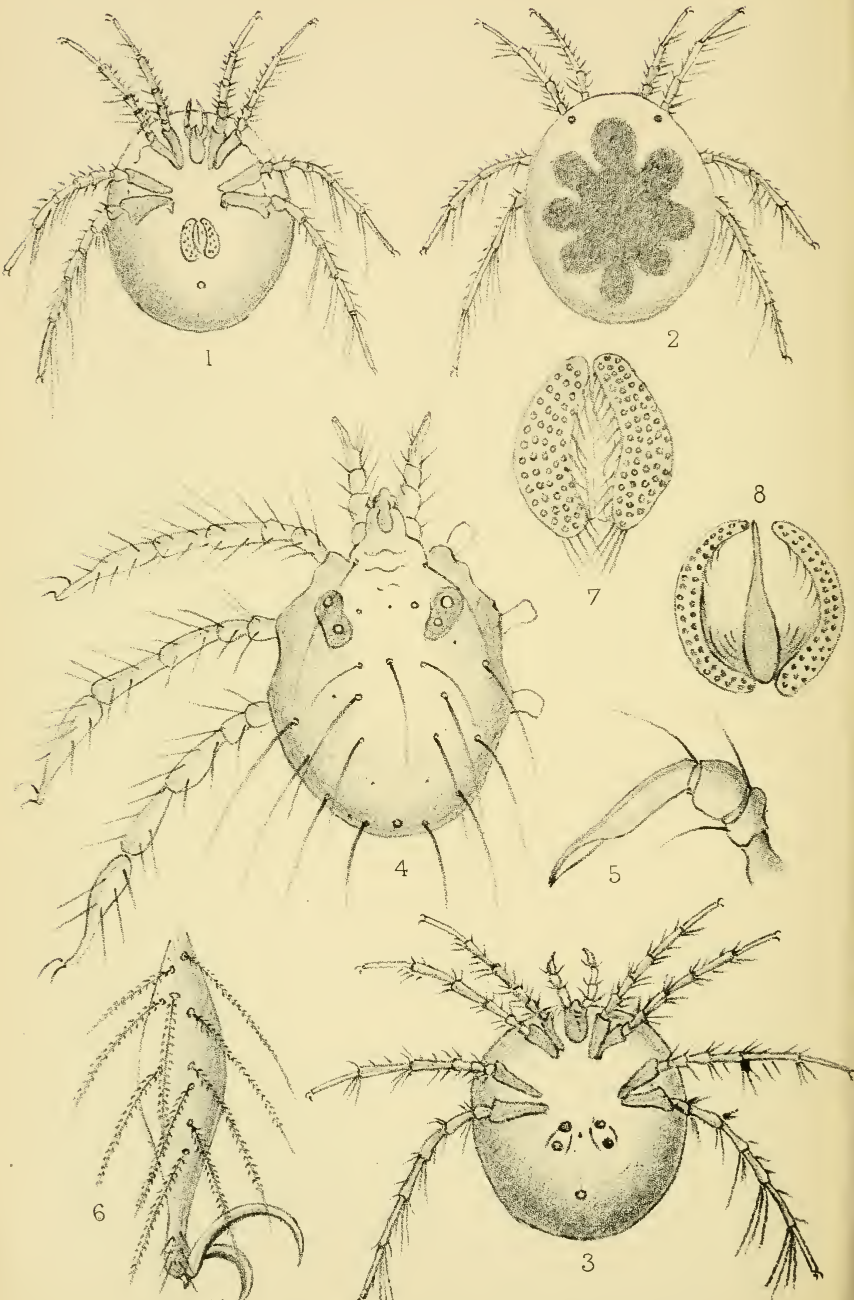
1882.—*Diplodontus filipes*, Haller, *Hydrachniden des Schweiz*, p. 47.

1885.—*Diplodontus filipes*, Krendousky, *Hydrachnidæ of Russia*, p. 123, Figs. 16—20.

1896.—*Diplodontus despiciens*, Koenike, *Farschungolerischte aus der Biologischen Station zu Plön.*

The first time I made the acquaintance of this Hydrachnid was at the Warren, Folkestone, in July, 1894; it is a very beautiful mite. The body is an ellipse in shape; sometimes it is more rounded than at others; it also varies very much in size, some females being quite twice the size of others; its average length is about 5/60 of an inch. The colour of the body varies very much, some being a brilliant red, whilst others are of a dirty yellow, and all intermediate shades. The whole of the surface of the body is covered with small papillæ. The dorsal surface is also strongly marked with a number of brown patches, sometimes radiating from the centre, and at others apparently in confusion and running in all directions. Eyes four, two showing plainly on the dorsal surface, and two on the ventral; the upper pair project and stand out in bold relief like glass beads. The legs are not very long, but are well supplied with swimming hairs; all the tarsi have claws. The colour also varies very considerably. I have found some with the legs of the same brilliant colouring as the body, whilst the legs of others have hairs of a bright yellow; so marked has been this distinction of colour in some cases, that I at first thought I had found a distinctly different species, but the structure in all cases has been identical. The palpus is chelate (see Fig. 5). In the larger specimens the mouth organs are so far under the body that the palpi cannot be observed from the dorsal side, but in the smaller specimens the last joint only can sometimes be seen. The genital plates are close up to the genital fissure, and are covered with a great number of raised dots. These dots are very small, but they are exceedingly numerous. I can distinguish no great distinctive difference in the sexes, except that which is seen in the genital fissure, as shown at Figs. 7 and 8, Plate XVI.

These interesting little creatures will live well in a tube at



Chas. D. Soar ad nat. del.

Diplodontus despiciens (mull.)

home, if the water is kept in good condition with pond weed. I have been fortunate enough to breed the larva. On June 1st this year I put a dozen *Diplodontus despiciens* adults into a tube by themselves, and on June 4th a quantity of ova was deposited on the side of the tube. The eggs or nuclei were embedded in an outer protoplasmic matter, in the same manner as I described in the paper on *Nesæa*. They were of a deep cadmium colour, the gelatinous-looking film being almost colourless. They passed through similar stages to those previously mentioned, and hatched out on June 16th. Their first object in life seemed to be to get out of the water and into the world as quickly as possible; they ran about like so many minute red spiders.

The movements of these little creatures were much more energetic out of the water than in, and I found some difficulty in getting one into a suitable position to draw (Fig. 4 is drawn from one in the life). It has four eyes on the dorsal surface, as shown in the drawing; six legs only, which is usual in the larval stage; the tarsi is broad at the widest part, and thin at the claw end; the claws, two in number, are curved backwards (see Fig. 6); the tarsi is covered with a quantity of long pectinated hairs. The colour of the larva is pink. Palpus is chelate, same as adult.

I have not been able to carry my investigations further than the larval stage, but have taken several specimens of the nymph, which is supposed to be the next stage, at Bealings this year (Fig. 3, in which note the arrangements of the genital pores); and at some future time I hope to be able to note and describe the whole life-history of these very interesting creatures from the ova to the adult.

Krendousky, in his work 1878, gives a very good outline drawing of the larva of this Hydrachnid. Müller's small figure of the adult is very good. Newman's figure is a beautiful drawing in colour, with red body and yellow legs.

EXPLANATION OF PLATE XVI.

Diplodontus despiciens (Müll.).

Fig. 1.—Ventral surface of adult.
,, 2.—Dorsal surface of adult.

Fig. 3.—Ventral surface of nymph, showing the difference in the genital area at this stage, and at that of the imago.
,, 4.—Dorsal surface of larva, drawn from a specimen hatched the same day.
,, 5.—Palpus of imago.
,, 6.—Tarsi and unguis of larva, showing the pectinated hairs.
,, 7.—Genital plates of ♀.
,, 8.—Genital plates of ♂.

The Binary Stars.*

By H. Wyles, L.D.S., Leeds.

SCATTERED throughout space are numbers of stars which, upon examination with the telescope, are seen to be double, two stars being visible where to the unaided eye there only appeared to be one. These double stars offer a great variety of appearances to the observer, the two components in some cases being widely separated and in others very close together, so that their separation requires a telescope of great size and perfection. Then, again, they are sometimes composed of two stars of the same apparent degree of brightness or of the same colour, and others appear of widely different magnitudes and of very different colours. They have been most carefully observed by astronomers for more than a hundred years, and they have yielded in return results and information of the most important and interesting nature. Who would have believed at one time that we should ever be able to weigh a star and say what its mass might be when compared with our own earth or with the sun? Yet this is only one of the results which assiduous observation of the binary stars has enabled astronomers to achieve.

The name of "binary" is only applied to those double stars in which the two components have been shown to have a physical connection with each other, and to form a pair which are really very near together in comparison with the immense distance which

*A paper read before the Leeds Astronomical Society March 11th, 1896.

separates them from us. Of course, it is certain that there are many stars which appear double when viewed with a telescope, in which the close proximity of the pair is merely apparent and not real, the two stars not being in any way connected with one another, one being immensely more distant than the other, and their apparent nearness to each other being merely due to perspective, both happening to lie very nearly in the same line of sight.

On the other hand, there are large numbers of double stars in which careful and persistent observation has brought to light the fact that both the components are moving in concert, and are in fact two suns performing revolutions round each other, or rather round the common centre of gravity of the pair, and it is these movements of revolution which have been made to yield such important results. Perhaps it will be best to divide the double stars into four classes :—

First, the binary stars proper, in which movements of revolution have been detected, such as Castor, 61 Cygni, and Sirius.

Second, pairs in which no such movement has been discovered (owing, perhaps, to its being too slow to be noticed), but in which a common proper motion of both components through space along parallel lines and in the same direction is found, rendering it more than probable that some physical connection exists between the pair—Mizar and its companion, together with Alcor in Ursa Major, may be taken as examples of this class.

Third, those doubles which are distinguished by quite opposite characteristics, and in which no movement of revolution can be detected, and where the proper motion of one is not participated in by the other. Vega is an instance of this class of star.

Our fourth class consists of those stars which—although we cannot see that they are double, and which no telescope in the world will show as more than a single point of light—we yet know by a process of reasoning (which is as certain in its results as ocular demonstration) to be really double, and to be composed of two suns revolving round one another, but placed so close together in comparison to the immense distance at which they are situated from us that the spectroscope alone is able to divide them, and to afford us proof of their double character. The primary star of the Mizar system (which, when taken together, has supplied an

example of our second class), if taken by itself, affords an example of this fourth class, as it is found to be a splendid spectroscopic double.

It is with stars of our first class, or binaries proper, in which revolution of the pair is visible, and of the fourth class, or spectroscopic binaries, in which the spectroscope declares revolution to exist, that we are now principally concerned. It was, I believe, Sir William Herschel who first discovered this movement of revolution more than a hundred years ago, and since that time some of these pairs have been watched through more than one complete revolution. It is not my intention to attempt the description of many of the binary stars separately, for their name is legion. I shall only single out one or two, and use them as examples to show the main principles of the methods of research which have been adopted, and the results which these researches have led to.

In the first place, when by observation we have learnt the time of revolution of the smaller star around the larger—or, rather, of the pair round their common centre of gravity—we can, if we also know the distance at which they are situated from us, tell the mass of the pair as compared with the mass of the sun. We will take Sirius as an example of this. The presence of a large and massive companion revolving round Sirius was suspected long before this companion was ever actually seen. It had been observed that the proper motion of Sirius was somewhat irregular, and it was confidently predicted by the illustrious astronomer, Bessel, that this irregularity of movement would be found to be caused by the disturbing influence of a large but comparatively faint companion, and this has since proved to be the fact. This body, which (like the planet Neptune) was known to exist before it was ever seen, owing to its perturbing influence upon the movements of Sirius, was first observed in 1862 by Alvan Clark, jun., one of the celebrated firm of American opticians, when testing a new and powerful refracting telescope which they had been making. I believe the object-glass of this telescope which first showed the companion to Sirius was eighteen inches in diameter, but it has since been seen with telescopes of much less size, for it is always found to be the case that when an object has once been discovered, observers provided with much smaller telescopes than the original discoverer

are able to see it. Many careful observations and measurements of the movements and positions of this companion to Sirius have now been made, and it has been found almost exactly to fulfil Bessel's prediction. It has been ascertained that it completes its revolution round its primary in about forty-nine years; also, as the distance of Sirius from us is approximately known, the actual distance in millions of miles which separates the pair can be calculated when their mean angular distance from one another in seconds of arc has been accurately measured. Now, taking the distance of Sirius from us at 100 billions of miles, an apparent mean angular separation between him and his companion of one second of arc would represent an actual distance between them of about 484 million miles.

When a number of careful measurements of the relative positions and angular separation of two stars have been made extending over a sufficient lapse of time, it is possible to map out the shape of the orbit which each is pursuing as seen from the earth, and to estimate approximately their mean angular distance from each other expressed in seconds of arc. There are some slight discrepancies in the various estimates of the mean angular distance separating Sirius and his companion as given by different observers; but it seems probable that this cannot differ much from seven seconds of arc. If, then, the mean distance separating Sirius and his companion is seven seconds as seen from the earth, then, as one second at the distance of Sirius represents, as I have said, 484 million miles, seven seconds will indicate an actual mean distance between the pair of 3388 million miles, or rather more than thirty-six times the distance from the earth to the sun. We are, therefore, able to make a comparison between Sirius and his companion on the one hand, and the sun and the planet Neptune on the other.

Now, Neptune is about thirty times as far from the sun as the earth is, and we will imagine that another planet existed in the solar system at the same distance from the sun as that which separates Sirius and his companion. Now, taking the earth's distance from the sun as unity, Neptune's would then be represented by the number 30, and the distance of our imaginary planet would then be 36. We know that Neptune completes the circuit

of his immense orbit in one hundred and sixty-five of our years, and by bringing Kepler's third law to bear upon the problem, we can easily discover what the period of revolution of this imaginary planet would be, situated at a distance from the sun represented by the number 36, as compared with Neptune, whose distance we represent by 30. Kepler's third law says that the square of the periodic time of a planet in the solar system always bears the same relation to the cube of its distance as in the case of any other planet, so that the square of the periodic time of our imaginary planet must bear the same relation to the cube of its distance (36) as the square of 165 (Neptune's periodic time) bears to the cube of Neptune's distance (30).

Now, if we work this out, we shall find that if such a planet existed in the solar system at the distance we have assigned to it, it would take about two hundred and seventeen years to revolve round the sun. But the companion to Sirius completes its revolution in forty-nine years; we therefore see that it revolves very much quicker in comparison to its distance from its primary than do the planets of the solar system; and we know that the greater the attraction of a central sun the quicker all its planets must revolve in order that they may not fall into it. It is evident, therefore, that the mass of Sirius must be much greater than that of the sun.

The law of gravitation, as discovered and explained by Sir Isaac Newton, tells us that the square of the time of revolution of any planet varies inversely as the gravitational pull existing between itself and its central sun, and the gravitational force exerted by two bodies upon each other at a given distance is directly proportional to their joint masses. Therefore, the mass of Sirius, together with his companion, is to the mass of the sun and his imaginary planet as the square of 217 is to the square of 49; that is to say, about nineteen times as great.

Now, the masses of the planets of the solar system are almost inappreciable when compared with the mass of the sun. The mass of our imaginary planet may therefore be left out of our calculation, and we therefore find that the joint mass of Sirius and his companion is nineteen times as great as the mass of the sun. The correctness of this result depends mainly upon the accuracy

of our knowledge on two points :—First, the mean angular distance of the two bodies apart; and secondly, the distance at which they are situated from us. (Their period of revolution it is comparatively easy to arrive at by direct observation.) If Sirius is less than 100 billion miles away, then, of course, an angular separation between him and his companion of 7 seconds of arc would not mean so great an actual distance between the pair as 3388 million miles. If Sirius is further off than we think, then, of course, seven seconds of arc separation between the pair would mean a greater number of miles between them. If, on the other hand, our measurement of the angular distance is not quite correct, but is either too great or too small, then the result of our calculation will be modified accordingly.

There are many other binary stars, the distances of which from the solar system are approximately known, and which it has therefore been possible to weigh in a similar way to Sirius and his companion by careful measurement of the distance of the pair from each other and observation of their periods of revolution.

The second of the four classes into which I have divided the double stars—namely, those in which no revolution has been detected, although the proper motion of the pair through space is in the same direction and along parallel lines, indicating that most probably some physical connection exists between them—is not nearly so interesting as the first class, or binaries proper, and it has added little to our astronomical knowledge.

To the third class, or merely optical doubles, we are indebted for our knowledge of the distances at which some of the stars are situated from us. The apparent shift in the position of the nearer of the two with regard to the more distant one, when viewed from opposite sides of the earth's orbit at intervals of six months, being the basis of the very elaborate and difficult calculations which have afforded us all the information we at present possess on this very interesting subject of stellar distances, a description of the methods by which this is accomplished is beyond the scope of this paper, and I will therefore pass to the consideration of our fourth class, or the spectroscopic doubles, which are two stars so close together in comparison to their distance from us that the spectroscope alone is able to divide them. Until the wonderful power

which the spectroscope possesses of measuring the velocity of the approach or retreat of a star towards or away from the earth in the line of sight was discovered, it had been impossible to detect any stellar movements except those which were at right angles to our line of sight, and these only by an elaborate series of most careful measurements of a star's exact position on the face of the heavens, made at intervals many years apart; but the discovery that when a star is approaching us, all the transverse lines in its spectrum are shifted slightly nearer the blue end of the coloured band into which the spectroscope expands the star's light than their position would otherwise have been, and that if the star is retreating from us all these lines are moved slightly out of their proper places in the opposite direction—namely, towards the red end, at once opened an altogether new field for research. But the spectroscope will do more than this: it will not only tell us at once whether a star is moving towards us or running away from us, quite irrespective of the star's distance away; but by measuring the amount by which all the lines are moved in one direction or the other, and making a comparison between this amount and the known velocity of light, it is possible to declare at what speed the star is moving. I do not propose to deal with the method of procedure by which these wonderful results are attained, as that is a subject which has already recently occupied the attention of this (the Leeds Astronomical) Society; I wish merely to describe some of these results.

We will take Mizar, the centre star of the three forming the tail of the Great Bear. I have already used this star as an example of stars of the second class, and until observed spectroscopically it did appear with its companion to belong rightly to this class, as no revolution of the companion round Mizar was discernible, and both of them, together with Alcor, the small star near them, appeared to possess proper motion in the same direction, rendering it probable that some physical connection exists between all the members of the group; but Sir Robert Ball, in his book, *In the High Heavens*, describes the remarkable results which have been obtained by the application of the spectroscope to Mizar, the principal star of the group, by Professor Pickering. Professor Pickering, it seems, has found that Mizar, as well as being a very easy and beautiful telescopic double belonging to our

second class, is, when taken by itself, altogether separate from its companions, found to be a very interesting spectroscopic double, for when the spectroscope was first applied to Mizar by Professor Pickering, he found that the lines in its spectrum were sometimes single and sometimes were all double. When double, one set of lines had been moved bodily a very little way towards the red end, whilst the other set had all shifted slightly towards the blue ; they then closed up again, and then shifted an equal amount in the opposite direction, thus showing that Mizar by itself, away from its companion, must really be two stars revolving round a common centre of gravity, so that at one point in their orbit (which must be placed almost edgeways to our line of vision) one star would be moving towards us while the other would be retreating from us, while when at the opposite points in their orbit the movements of each star towards or away from us would of course be reversed. When crossing our line of sight at right angles, the spectroscope would show no movement at all, and the double set of lines from the two stars would close up into one set and appear single. As each set of lines is moved about an equal distance in an opposite direction, it appears that each of the two components is moving at about the same speed, which the spectroscope declares to be approximately fifty miles a second, and it is only necessary to note the time taken for the lines to open out and close up again twice to arrive at the length of time occupied in performing one revolution of the orbit. This is found to be one hundred and four days.

As, therefore, we know the time taken, and also the speed, we can easily calculate the length of the path travelled, or the circumference of the orbit round which both the stars are moving, and its diameter will therefore represent the distance separating the two stars. This distance between them is found in round numbers to be about 150 million miles.

The mathematician is now provided with all the necessary data to enable him to weigh these two companions, and arrive at their joint mass as compared to the mass of the sun. It is to be observed that the spectroscope has provided him with all this information on which to base his calculation, quite regardless of what the star's distance may be from us. He knows that the distance separating the components is 150 million miles, and he

knows that their revolution is performed in a hundred and four days; he is therefore able to proceed with his calculation in the same way as I have described in the case of Sirius, and he finds that the combined masses of the two stars forming the spectroscopic double which we call Mizar is no less than forty times as great as the mass of the sun.

I will now describe one other very wonderful result which has followed the application of this spectroscopic method of research to one other star, which, although very different from any I have before mentioned, must yet be placed in our fourth class among the spectroscopic binaries. This star is the famous and well-known variable Algol in the constellation Perseus. Although believed to be a binary before the spectroscope was ever applied to it, yet it seemed impossible that the supposition could ever be proved, until the spectroscope furnished us with most convincing evidence of the fact. The remarkable variability in the light of Algol had attracted attention to it for centuries, as its changes of lustre are quite perceptible to the unaided eye; and several theories accounting for the vagaries of the star have been propounded. But the one which has commanded most respect, and which was generally believed by astronomers to be the correct solution of the mystery attaching to Algol, was one which assumed that Algol was one of the binary stars having a large dark companion revolving round him, so that it sometimes passed in front of him as seen from the earth, thereby cutting off a portion of his light, or in other words partially eclipsing him; and it is this theory which has received such wonderful confirmation from the spectroscope. The variability of Algol has been found to be almost perfectly regular, and the star passes through the complete cycle of its changes in a period which has been ascertained with great accuracy to be 2 days 20 hours 48 minutes and 51 seconds. For a period of 2 days $13\frac{1}{2}$ hours, Algol shines with a steady light as a star of the second magnitude; then his brightness begins gradually to decline, and for $3\frac{1}{2}$ hours he slowly becomes fainter, till he has lost about three-fifths of his light. At this, the lowest point, his brightness appears to remain stationary for about twenty minutes, and then it begins to increase in the same way that it before diminished, until in $3\frac{1}{2}$ hours from the time of minimum

Algol has again attained his maximum brilliancy, and this he retains for another period of 2 days 13½ hours, after which he goes through exactly the same changes again. The theory of a partial eclipse by a dark companion was a perfectly feasible one, but it could not be proved without the spectroscope, as no telescope would show Algol as a disc of any appreciable size, but merely (like all the other fixed stars) as a point of light. This could be seen to vary in brightness, but of course not in shape, as would be the case if we were near enough to see the passage of a dark satellite in front, partially eclipsing the star. This we can never hope to actually see, but the spectroscope enables us to see it with our mind's eye, and with little less certainty of its truth than if we saw it in reality.

Professor Vogel first applied the spectroscope to Algol, and he then found that the star was approaching the earth at a speed of something like twenty-six miles a second. When next he tried it he found that Algol was receding from us at about twenty-six miles a second. He tried again and again, and found that the star was really moving with a maximum velocity of twenty-six miles a second, sometimes towards the earth and sometimes away from us, and sometimes it appeared to stand still. Vogel found that, at the conclusion of the period of approach, Algol appeared to be stationary. Then a slow movement of retreat began, which gradually increased till a speed of twenty-six miles a second was attained. Then this gradually declined until he appeared again to stand still. Then a slow movement of approach began, which also gradually attained a maximum speed of twenty-six miles a second, and then slowly decreased until again no movement at all was perceptible.

Now, it is quite impossible to suppose that Algol can run along in a straight line with first accelerating and then diminishing velocity, and stop and turn back at each end of his course. Such a movement would be quite at variance to all astronomical movements with which we are acquainted, and it is impossible to invent any system of forces which would produce or explain such an erratic movement on the part of one of the stars ; yet this is what the spectroscope at first sight declared Algol to be doing But it must be borne in mind that the spectroscope cannot show move-

ments across our line of sight; and if, therefore, Algol be really moving at twenty-six miles a second round a nearly circular orbit placed edgeways to us, this will explain perfectly the appearances presented, as the spectroscope would only show the movement at the sides of the orbit, when either approaching us or retreating from us, and not at all when crossing our line of sight at the nearest and the most distant points in the orbit. Vogel also found that the time of this revolution of Algol in an orbit, as shown by the spectroscope, corresponded exactly with the complete cycle of variability, namely, 2 days 20 hours 48 minutes and 51 seconds. It seemed certain, therefore, that a connection must exist between the orbital revolution and the variability; and to strengthen this probability he also found that the minimum always occurred at the conclusion of Algol's movement of retreat from the earth.

These facts have furnished the mathematician with all the data he requires for explaining the variability of Algol, and for finding out a great many things about him. As the time he takes to complete a revolution of his orbit and also his velocity are both known, the size of his orbit is at once ascertained. This is found to be a little more than six million miles in circumference, or, in round numbers, two million miles in diameter. It is evident, therefore, that there must be some invisible body of large mass near to Algol, causing him to revolve in this orbit. The next point for consideration is the amount of light lost when at minimum, and this is about three-fifths of the whole, the dark body being only able to cover three-fifths of Algol's surface, so that two-fifths therefore remain uneclipsed. This minimum lasts for twenty minutes, and then the star rather suddenly begins to brighten. The dark satellite must therefore remain wholly in front of Algol for twenty minutes, aud then begin to pass off. The total time which the two bodies take to pass one another completely must now be taken into account. This is found, by careful observation, to be about seven hours and a quarter.

Now if we know the velocity with which each of the globes is moving, we shall be able to arrive at their respective diameters, seeing that one eclipses three-fifths of the other's light for twenty minutes, and they take seven and a quarter hours to pass each other. The velocity of Algol, the spectroscope tells us, is twenty-

six miles per second, and, assuming the same density for both the bodies (which is the only element of doubt in the calculation), it has been shown that a dark companion of the required size, relatively to Algol, would really have just about half his mass, and must revolve in an orbit twice as large, or about four million miles in diameter. The centre of gravity round which both the bodies revolve must therefore lie at a point between them which is situated at twice as great a distance from the centre of the smaller body (the dark companion) as it is from the centre of Algol; and as both must revolve round their common centre of gravity in the same time, it follows that the dark companion, whose orbit is twice as large as Algol's, must travel twice as fast, namely, fifty-two miles per second.

The orbital velocity of the companion having in this way been ascertained, and that of Algol declared by the spectroscope to be twenty-six miles per second, and also knowing that seven and a quarter hours are required for the two bodies to pass one another, it has therefore been possible, for the first time in the history of astronomy, to say, with what must certainly be a very near approach to the truth, what the size of one at least among the host of stars is; and Algol is declared to be just about a million miles in diameter, or nearly twice as big in bulk as our sun, and his companion about 800,000 miles, or very nearly the same size as the sun. This is a noteworthy achievement in astronomy. We have known for many years what the masses of many of the stars are as explained in the former part of my paper, but no astronomer has ever before been able to say what the actual size of any star really is. The stars could, in many cases, be weighed, but it was impossible to measure them.

As I have said, the only element of doubt in this calculation is that it assumes the same density for both Algol and his dark companion. If this is not the case it will, of course, modify the result somewhat, but this is a matter which it is impossible to put to the test with the resources at present at the command of science. Algol's companion is a body which has never been seen, and I think I may safely say that it never can be seen from our earth, and it is all the more wonderful therefore that science has been able to teach us so much about a body which we can never

hope to see. It is noteworthy also that in all this the distance of the Algol system from the earth is of no account, and in no way enters into or affects the calculation.

It has also been possible to weigh Algol and his companion, and ascertain their masses, in the same way as the masses of other binary stars have been discovered, and we are assured that though Algol is about twice as big as the sun (that is to say, has about twice the sun's bulk), yet he is made of much lighter materials, as he only weighs about half as much, and the companion, though about the same size as the sun, only weighs about one fourth of the sun's weight.

Sir Robert Ball has drawn attention to the (as he terms it) monstrous proportion which exists between the sizes of Algol and his companion, and their distances apart, as compared with dimensions and distances in the solar system; for, whereas Algol is about a million miles in diameter, and his companion about 800,000 miles, yet they are only about, in round numbers, three million miles apart from centre to centre; and I will conclude my paper by borrowing one of Sir Robert Ball's illustrations for you to remember the relative sizes and distance apart of Algol and his companion by; and this is, that if we take a shilling to represent Algol and a sixpence to illustrate the size of his companion, and place them so that their rims are two inches apart, they will fairly represent, with regard to relative sizes and distance apart, the proportions of this wonderful and interesting Algol system.

ARCTIC HAIL AND THUNDERSTORMS.—Mr. H. Harries read a paper before the Royal Meteorological Society on June 17th, 1896, on "Arctic Hail and Thunderstorms," in which he showed that the commonly-accepted opinion that hail and thunderstorms are almost, if not quite, unknown in the Arctic regions, is incorrect. He had examined a hundred logs of vessels which had visited the Arctic regions, and found that out of that number no fewer than seventy-three showed that hail was experienced at some time or another. Thunderstorms were not so frequent as hail, but they have been observed in seven months out of the twelve, the month of greatest frequency being August. Mr. Harries is of opinion that the breeding place of thunderstorms in these high latitudes is in the neighbourhood of Barent's sea.—*Science.*

Leaves from my Note-Book: Gleanings from an Old Field—(*continued*).

By Mrs. Alice Bodington.

I HAVE noted down a few out of the many striking instances given by Darwin as to Bud-variation and Graft-hybrids* in various plants, showing that the somatic cells are capable of producing varieties of every kind without the intervention of the sexual organs.† Darwin also enters at length into the subject of those sudden variations known to gardeners as "sports." That these sudden variations are due to some law or laws one cannot doubt; yet I think little or nothing is known, even now, about the mode of action of these laws. Often we recognise a "memory of cells," by which old and perhaps long-lost ancestral characteristics are revived; but quite as often Nature seems to have resolved upon making a sudden change, as in the case of the yellow magnum-bonum plum tree, which after forty years produced a branch bearing purple plums.

As in the dog, we find a new species descended from the wolf or the jackal, so in the peach we have a new species descended from the almond, with what may be called a grandchild in the shape of the nectarine. The peach is nowhere found wild. It was introduced into Europe a little before the Christian era, and from the fact of its not having a pure Sanscrit or Hebrew name, it is supposed to have originated in Far Eastern Asia, where the double-flowering Chinese peach still shows transitional qualities. The fruit of this Chinese peach is much elongated and flattened, with the flesh both bitter and sweet, but not uneatable.‡ From

**Animals and Plants under Domestication*, Vol. I., Chaps. IX., X., XI., XII.

†Chap. xi., p. 398—"These cases prove that those authors . . . are in error . . . who attribute all variability to the mere act of sexual union."

‡Chap. x., p. 359. Van Mons states that he once raised from a peach-stone a peach having the aspect of a wild tree, with fruit like that of the almond. The French peach-almond bears a fruit oval and swollen, with the aspect of a peach, including a hard stone with a fleshy covering, which is sometimes eatable. A peach-almond grafted on a peach bore during 1863 and 1864 almonds alone; but in 1865 bore six peaches and no almonds. A double-flowered almond, after producing almonds during several years, suddenly bore for two years spherical, fleshy, peach-like fruits, and then reverted to its former state and produced large almonds.

this stage, says Darwin, one small step leads us to such inferior peaches as are occasionally raised from seed.

The late origin of the nectarine, as a "sport" from the peach, makes its history particularly interesting. Late as is the origin of the nectarine, it reproduces itself truly by seed, as does the peach; and both show an equal tendency to sport. Peter Collinson in 1741 recorded the first case of a peach tree producing a nectarine, and in 1766 he added two other instances. Mr. Salisbury, in 1808, records six cases of peach trees producing nectarines; one of the varieties, the Royal George, had the habit of producing both kinds of fruit. In short, the evidence is superabundant for full-grown peach-trees suddenly producing nectarines by bud-variation.

Mr. Rivers (p. 361) states that from stones of three varieties of the peach he raised three varieties of nectarine, and in one of these cases *no nectarine grew near the parent peach tree.* . . . . Of the converse case—namely, of nectarine stones yielding peach trees (both free and cling stones), we have six undoubted instances recorded by Mr. Rivers. Sir J. E. Smith gives the remarkable case of a tree in Norfolk which usually bore both perfect nectarines and perfect peaches, but during two seasons bore "half-and-half fruit;" that is, one half a perfect peach and the other a perfect nectarine.

Darwin sums up the case thus:—"We have excellent evidence of peach stones producing nectarine trees, and of nectarine stones producing peach trees; of the same tree bearing peaches and nectarines; of peach trees suddenly bearing nectarines by bud variation (such nectarines reproducing nectarines by seed), as well as fruit part nectarine and part peach,* and lastly of one nectarine tree, first bearing half-and-half fruit, and subsequently true peaches. As the peach came into existence before the nectarine, it might have been expected from the law of reversion that nectarines would have given birth by bud variation, or by seed to peaches, oftener than peaches to nectarines, but this is by no means the case" (p. 362). Can any theory fit such bewildering facts?

*The "Royal George" peach produced a fruit three-quarters peach and one-quarter nectarine, quite distinct in appearance as well as in flavour. The lines of division were longitudinal.

That extraordinary monster, the St. Valéry apple, must not be passed over (p. 371):—

"The flower has a double calyx with ten divisions and fourteen styles, surmounted by conspicuous oblique stigmas, but is destitute of stamens or corolla. The fruit is constricted round the middle, and is formed by five seed-cells, surmounted by nine other cells. Not being provided with stamens, the fruit requires artificial fertilisation, and the girls of St. Valéry annually go to '*faire ses pommes*,' each marking her own fruit with a ribbon; and as different pollen is used the fruit differs, and we have an instance of the direct action of foreign pollen on the mother plant." The contrast between the St. Valéry apple, with its fourteen seed-cells, and the pigeon apple, which has only four cells, is certainly very great. Another odd instance of a "sporting" tendency is given on pp. 348—9, where one pea-plant produced four sub-varieties—viz., blue and round, blue and wrinkled, white and round, and white and wrinkled peas; and though the grower, Mr. Masters, sowed these four varieties separately during several successive years, *each kind always reproduced all four kinds mixed together.*

Sporting in Plums (p. 399).—The *grosse mignonne* peach at Montrueil developed a sporting branch, the "*grosse mignonne tardive*," a most excellent fruit, which ripens a fortnight sooner than that of the parent tree, and this same peach has produced by bud variation the *early grosse mignonne.* By no possible theory, it seems, can one account for the same tree producing a late and an early fruiting sport.

A tree of yellow magnum bonum plums, forty years old, produced a branch which yielded red magnum bonums. A single tree out of four or five hundred trees of the "Early Prolific" plum, descended from an old French variety bearing purple fruit, produced when about ten years old bright yellow plums.

Chrysanthemum (p. 404).—A seedling, raised by Mr. Salter, *produced by bud variation six distinct sorts*, five different in colour and one in foliage, *all of which are now fixed.* When a branch of chrysanthemum sports into a new variety, says Mr. Salter, it can generally be propagated and kept true.

Rose.—The history of the moss-rose is peculiar; it is supposed to have arisen from the Provence rose (*R. centifolia*) by bud

variation, for the branches of the common moss-rose tree have several times been known to produce Provence roses. The common moss-rose, by bud variation, has produced three varieties. Prof. Casparz has carefully described the case of a six-year-old white moss-rose which sent up several suckers, one of which was thorny and produced *red flowers destitute of moss*, exactly like that of the Provence rose; another shoot bore both kinds of flowers, and in addition longitudinally striped flowers. This white moss-rose had been grafted on a Provence rose; but how curious is the fact that the influence of the stock lay dormant for six years!

Sporting Potatoes (p. 410).—A single eye in a tuber of the old *Forty-fold potato*, which is a purple variety, was observed to become white. This eye was cut out and planted separately, and the kind has since been largely propagated. A whole white tuber was also produced by this variety of purple potato, and has been propagated and kept true. Mr. R. Trail stated in 1867 that several years ago he had cut about sixty blue and white potatoes into halves through the eyes or buds, and then carefully joined them, destroying at the same time the other eyes (p. 420). Some of these united tubers produced white and others blue tubers. Some, however, produced tubers partly white and partly blue, and the tubers from four or five were regularly mottled with the two colours. In these latter cases we may conclude, says Darwin, that a stem had been formed by the union of the bisected buds—that is, by graft-hybridisation.

Mr. Taylor, who had received several accounts of potatoes having been grafted by wedge-shaped pieces of one variety inserted into another, though sceptical on the subject, made twenty-four experiments, which he described in detail before the Horticultural Society. He thus raised many new varieties—some like the graft and some like the stock, others having an intermediate character. (Can anything demonstrate more forcibly that the principle of heredity and the power of variation are distributed throughout the somatic cells?) Several persons witnessed the digging up of the tubers from these graft-hybrids, and one of them, Mr. Jameson, a large dealer in potatoes, writes thus:—"They were such a mixed lot as I have never before or since seen. They

were of all colours and shapes, some very ugly and some very handsome." Another witness says:—"Some were round, some kidney, some pink-eyed kidney, piebald and mottled red and purple, of all shapes and sizes." Some of these varieties have been found valuable and have been propagated.

Numerous instances are given at great length of the production of graft-hybrids, sometimes the tubers being grafted and sometimes the stems. Mr. Fearing-Burr, a very careful experimenter, produced distinctly mottled and most curious potatoes by inserting eyes from blue or red potatoes into the substance of white ones, after removing the eyes of the latter. (Letter from Mr. Merrick, of Boston, U.S.A., to Darwin in 1871.) In Germany, Herren Reuer and Lindemuth, both attached to the Royal Gardens of Berlin, inserted eyes of red potatoes into white ones and *vice-versa*. Many forms partaking of the characters of the inserted bud and stock were obtained; for instance, some of the tubers were white, with red eyes.

"Characters of all kinds," says Darwin, "are affected by graft-hybridisation, in whatever way the grafting has been effected. . . . Herr Magnus asserts with much truth that graft hybrids resemble in every respect seminal hybrids, including their great diversity of character. However, the characters of the parent forms are not often homogeneously blended in graft hybrids. . . It would seem that the reproductive elements are not so completely blended by grafting as by sexual generation. . . . Finally, it must, I think, be admitted that we learn from the foregoing cases a highly important physiological fact—namely, *that the elements that go to the production of a new being are not necessarily formed by the male and female organs*. They are present in the cellular tissue in such a state that they can unite without the aid of the sexual organs, and thus give rise to a new bud partaking of the characters of the two parent forms" (pp. 423—4).

I will give two very curious cases of graft hybrids, one being the *Cytisus Adami* and the other the famous *bizarria* orange:—

"The *Cytisus Adami* is a graft hybrid; that is, it was produced from the *united cellular tissue of two distinct species*. Mr. Adam, who raised the original plant, procured this variety by inserting a shield of the bark of *C. purpureus* into a stock of *C.*

laburnum, and the bud lay dormant, as often happens, for a year. The shield then produced many buds and shoots, one of which grew more upright and vigorous, with larger leaves than shoots of *C. purpureus*, and was consequently propagated. Now, it deserves especial notice that these plants were sold by Mr. Adam as a variety of *C. purpureus* before they had flowered, and the account was published by Poiteau after the plants had flowered, but before they had exhibited their remarkable tendency to revert into the two parent species, so that there was no conceivable motive for falsification. . . . If we admit Mr. Adam's account as true, we must admit the extraordinary fact that two distinct species can unite by their cellular tissue and subsequently produce a plant, ... resembling in every important respect a hybrid formed in the ordinary way by seminal reproduction" (p. 417).

Throughout Europe, in different soils and under different climates, branches of the *Cytisus Adami* have repeatedly and suddenly reverted to the two parent species in their flowers and leaves. To see mingled on the same tree tufts of dingy red, bright yellow, and purple flowers, borne on branches having widely different leaves and manner of growth, is a surprising sight. "I have seen a single flower," says Darwin, "divided into halves, one side being bright yellow and the other purple, so that one half of the standard petal was yellow and of larger size and the other half purple and smaller." The most remarkable fact about this tree is that in its intermediate state, even when growing near the parent species, it is quite sterile; but when the flowers become pure yellow or pure purple, they yield seed. . . . Two seedlings reared by Mr. Herbert from the seed of yellow flowers exhibited a purple tinge in the stalks of their flowers; but several seedlings raised by Darwin resembled in every character the common laburnum, with the exception that some of the stems had extremely long racemes. These seedlings were perfectly fertile. That such purity of character and fertility should be suddenly recognised in so sterile a form is an astonishing phenomenon. Darwin proceeds to enter into minute details as to the condition of the ovules and pollen in the sterile forms.

The famous *bizzaria* orange offers a strictly parallel case to that of *Cytisus Adami*. The gardener who in 1644 in Florence

raised the tree declared that it was a seedling that had been grafted, and, *after the graft had perished*, the stock sprouted and produced the *bizzaria*. Gallesis, who carefully examined several living specimens and compared them with the description given by the original describer, P. Nato, states that the tree produces at the same time leaves, flowers, and fruit identical with the bitter orange and with the citron of Florence; and likewise compound fruit, with the two kinds either blended together, both externally and internally, or segregated in various ways.

I can find nothing as to the way in which the blood-orange is raised. I have always understood it is produced by grafting the orange on the pomegranate. If so, it shows the strong influence which the stock can exercise on a graft, since these oranges are not only permeated with a deep-red colour, but the flavour is very much affected.

Vines.—Gärtner (p. 419) quotes two separate accounts of branches of dark- and white-fruited vines which had been united in various ways, such as being split longitudinally and then joined, etc.; and these branches produced distinct bunches of grapes of the two colours, and other bunches with berries either striped or of an intermediate new tint. Even the leaves in one case were variegated. What is particularly curious is that attempts to raise variegated grapes by fertilising white kinds with pollen of dark kinds failed.

Bulbs of blue and red hyacinths may also be cut in two, and they will grow together and throw up a united stem, with flowers of the two colours on the opposite sides, or in some cases with the two colours blended together.

"The facts given in this chapter" (chap. XI.), says Darwin, "prove in how close and remarkable a manner the germ of a fertilised seed and the small cellular mass forming a bud resemble each other in all their functions—in their power of inheritance, with occasional reversion, and in their capacity for variation of the same general nature, in obedience to the same laws. This resemblance—*or, rather, identity of character*—is shown in the most striking manner by the fact that the cellular tissue of one species or variety, when budded or grafted on another, may give rise to a bud having an intermediate character. We have seen that varia-

bility does not depend on sexual generation. . . . We have seen that bud variation is not solely dependent upon reversion or atavism to long-lost characters, or to those formerly acquired from a cross, but appear often to be spontaneous. But when we ask ourselves the cause of any particular variation, we are lost in doubt." In chap. XII. Darwin goes at great length into the question of the capriciousness of the inheritance of variations. For instance, he mentions some seedlings of a peculiarly coloured balsam, which all resembled their parent; but of these seedlings some failed to transmit the new character, whilst others transmitted it to all their descendants during several successive generations. The "weeping" or pendulous growth of trees is strongly inherited in some cases, and without any assignable reason feebly in other cases. A weeping, or rather a prostrate, yew was found in a hedge in Shropshire. It was a male, but one branch bore female flowers and produced berries; these, being sown, produced seventeen trees, all of which inherited the peculiar habit of their parent. On the other hand, seeds of the weeping beech, sown by Mr. MacNab, produced only common beeches. Mr. Rivers, at Darwin's request, raised a number of seedlings from three distinct varieties of the weeping elm; . . but none of the young trees showed the least signs of weeping. Mr. Rivers had sown above twenty thousand seeds of the weeping ash, and *not a single seedling was in the least pendulous*. Other weeping ashes have faithfully transmitted their characteristic quality, so that the apparent capriciousness of inheritance could not be better exemplified.

I think I have quoted enough on this subject to induce anyone who is interested in it to examine all the instances given by Darwin for himself, and if so my object in making these notes will have been attained.

As Leaves from a Note-book may be allowed to be a little discursive, I will conclude this paper with some Notes taken from the *Spectator* relating to the instincts and habits of birds.

Peculiar Mode of Hatching.

Mr. Edmund Tregear,* writing from Wellington, New Zealand, says:—"The great penguin of the Antarctic Circle, standing with

* "The Problem of Arctic Life," *Spectator*, Jan. 18th, 1896.

its head as high as a man's waist, hatches its eggs in a very peculiar manner. These are not brooded after the manner of most birds' eggs. The female lays two eggs. The first she hands over to the male bird; the second she keeps. The egg is held *on the upper surface of the large flat feet*, and is pushed up under the waistcoat of thick feathers. It is there held close to the body, whose warmth gradually vitalises the young bird. So tenacious are the parent birds of this grip, that if you knock one of them over it will fall over on its back with its foot stuck stiffly out, still clutching the egg to its body.

Maintenance of Life in very Low and very High Latitudes.

With regard to the curious puzzle as to how highly organised creatures can flourish in very high or very low latitudes, Mr. Tregear says that between New Zealand and the Antarctic Circle are numbers of islands, many of which are barren and others covered with scrub, where tens of thousands of penguins and other sea-birds make their nurseries. When, during the summer, the eggs have been hatched and the young reared, the younger generation is left, and the adults set out for the lands round the South Pole. They leave in autumn thin and attenuated; they go for the winter to the clime of eternal snow and ice; and they return six months afterwards as fat as butter to their old haunts. Their squadrons, swimming in long columns, cover the sea for miles. When one part of the bird-army strikes its regular nesting-place, it appears as if word were passed round. The proper inhabitants of the spot collect and take possession, pushing the youngsters of last year out to sea. The others wheel their lines to left and right round the obstacle, and push on northward to their usual summer homes. It seems that beyond the great belt of ice-cliffs, which bar the way to the South Pole, there must be pleasant fiords and bays where the penguins fish and fatten. I neglected to take notes—except in my memory—of the extraordinary manner in which Nature provides "cold storage" for bird-life in Siberia. I believe I can correctly give the main facts. There are at least six species of birds visiting England in the winter whose nesting-place is unknown. A gentleman, deeply interested in the subject,

determined if possible to discover the summer resort of these transitory visitors. His researches led him as far as the *Tundras* of Siberia, which, it is needless to say, in the winter presented the very embodiment of desolation. But with the very first melting of the snow an extraordinary change occurred, and the hitherto solitary wastes were enlivened with the arrival of thousands upon thousands of birds. No sooner had they alighted, than they began greedily feeding, and then it appeared that the snow had acted as a preservative for countless berries. Fear of the oncoming cold evidently drives the birds south before the berries have time to ripen in the autumn, but under the snow they are perfectly preserved till the birds return in the nesting season. In this region were found the nesting-places of three of the species, whose nesting-places had been unknown; the other three sought regions still further north, and their nests and eggs remain to be discovered.

The Wild Fowl of Holkham.—To all those who love to read of, or to watch, the habits of living animals, the articles which have appeared during the last few months in the *Spectator* are a great delight. Sometimes the writer takes us down to the shore, and we can in imagination follow that intrepid lobster-catcher who prefers the use of his bare hands to any other mode of catching lobsters. His success in so peculiarly difficult a task is founded on the intimate knowledge he has attained of all the "little ways" of lobsters, which includes the romantic habit of the male and female lobsters, which go hand in hand—I mean claw in claw—to browse upon the seaweeds of the foreshore. Or we can follow the cormorants off the Isle of Wight leading a wild life in the dashing waves, yet occasionally condescending to form a circle which gradually drives a shoal of fish towards the shore, where they can be devoured at leisure. Sometimes the cormorants become entangled in the bars of the buoys which guard the Needles, and they can only be rescued by a man as brave as our friend the lobster-catcher, who can disregard "beaks that cut like shears."

But the account of the happy bird-life of Holkham Lake and other protected waters is quite as delightful. The modifications of instinct are very peculiar, varying, of course, according to the particular species, but all tending to show that the fear of man is

an acquired instinct. "Under some lofty trees on the opposite side of the lake," says the author, "were a number of dark objects, from eighty to a hundred; and opinions varied as to whether these creatures were sheep or deer lying asleep. They proved to be a flock of Canada geese. . . . The birds regularly leave the water at certain hours, and fly into the marshes of 'Holkham Meals' between the park and the sea, where they feed by day with the famous wild grey geese of Holkham and nest like wild birds in the long line of sand-hills between Holkham Bay and Wells Harbour. A nearer view of the lake showed the enormous number of indigenous wild-fowl there collected. The edge is as regular as that of the Long Water in Kensington Gardens, and the grass is cropped short with the grazing of the geese. Above lies the grey palace of Holkham Hall, and the outline of the water is as regular as that of the Italian windows on the façade of the house. Yet the fowl lie as thick as ducks upon a mill-pond, though the gulls hovering over the surface, or floating like white boats amongst the ducks, show that this is no home of half-domesticated birds, but the chosen resort of fowl from the adjacent levels of the shallow northern sea. In rough and stormy weather, or long frosts, the true sea-ducks visit the lake. But in mild seasons only mallards, widgeon, and teal visit the lake. . . . When disturbed, the whole company rose to their feet and ran towards the water, the duck and widgeon rising with a rush and clatter of wings, and plunging into the centre of the water, whilst the sooty coots ran till they reached the water's edge, and then launched themselves in a black fleet among the gay, parti-coloured ducks. . . . . Though so wild and wary beyond the limits of sanctuary, the birds are here almost as tame as those upon the ornamental waters of the London parks. They stream off from the bank as the visitor approaches, alighting on the water at a distance of fifty yards, and take no further notice of the intruder. Beyond the lake is a grove of ilex and pine.

Where the ilex-grove ends, a bed of dried, rough grass fringes the water, through which a narrow-beaten track, made by foot-passengers and deer, runs to join the road across the dam. Something which was neither grass nor bushes blocked this track at the time of the writer's visit, apparently a dense growth of teazle-tops.

A nearer view showed this to be a line of ducks' heads, all turned in one direction. The birds were standing on the path in a long line facing the water, the approach of the visitors having given the signal of "eyes left" to the whole regiment. Some five or six hundred mallard were soon afloat upon the water, while flight after flight of widgeon were seen passing over at a great height from the sea, to join those at the head of the lake.

"Both wild-duck and widgeon leave the lake at night to feed in the vast stretch of creeks, samphire, salt-marshes, and half-reclaimed land which lends such strange beauty to the line of shore between Wells and Blakeney. In their choice of the hour of departure, these two species, so alike in form and in their habits when in security, exhibit one of those unexplained differences in degree of caution in the avoidance of danger, which is one of the puzzles of the sportsman-naturalist. The wild-duck leave at dusk, and nightly risk the chance of a shot from the 'gunners' waiting on the marshes at flight time. The widgeon wait till dark, and, except on moonlight nights, seldom lose any of their number to the gun. As the fowlers are tramping home across the flats, they hear the widgeon 'like gales of wind' rushing high over the marshes; but the flocks are invisible, except when the moon is for a moment darkened by 'a misk o' ducks' flitting across its beams in the winter sky."*

These habits of the various species of wild-fowl enable one to understand how the old hermits in their solitary cells in the wild fens of Saxon times heard such inexplicable rustlings and movements in the meres; such strange shrieks and wailings in the air, so that to their excited fancy it seemed that the air and waters teamed with evil spirits. And that weird flight of the widgeon in flocks, invisible except when the moon is for a moment darkened by a "misk o' ducks," gives meaning to the Celtic superstition that the spirits of the dead could be heard wailing high in air, as they sought their birthplace beyond the ocean.

* *Spectator*, Jan. 18th, 1896.

Micrometry.*

By E. G. Love. Plate XV.

WHOEVER undertakes any serious work with the microscope is confronted, sooner or later, with the necessity for some method of determining the actual size of microscopic objects; and it may not be without profit if we briefly review the different methods for ascertaining this.

As we might naturally suppose, the earliest efforts in micrometry consisted in comparing the microscopic object with other objects whose approximate size was known or could easily be determined. Thus Leeuwenhoek employed grains of sea-sand of such size that one hundred of them, placed side by side, extended one inch. One of the sand grains was so placed that it could be directly compared with the object under the microscope. The same idea was adopted by later microscopists who employed the very small spores of certain plants.

Hooke, as early as 1675, described a method for determining the magnifying power of a microscope. To use his own words: "Having rectified the Microscope, to see the desired Object through it very distinctly; at the same time that I look upon the Object through the Glass with one Eye, I look upon other Objects at the same Distance with my other bare Eye: by which means I am able, by the Help of a Ruler divided into Inches and small Parts, and laid on the Pedestal of the Microscope, to cast as it were the magnified Appearance of the Object upon the Ruler, and thereby exactly to measure the Diameter it appears of through the Glass; which, being compared with the Diameter it appears of to the naked Eye, will easily afford the Quantity of its being magnified." While Hooke referred to the determination of the magnifying power, and that with objects capable of being measured without the aid of the microscope, the same method is applicable to ordinary micrometer work.

Dr. James Jurin wound a piece of very fine silver wire about a pin, leaving no space between the threads, measured any length

* Substance of some remarks made before the New York Microscopical Society. From the *Journal of the New York Microscopical Society.*

of the coil, and then by counting the number of threads found the diameter of the wire. This was then cut into small pieces, and one of them was placed upon or near the object to be measured, and a comparison made. That this method was very crude is evidenced by the fact that Jurin found the diameter of a human blood corpuscle to be 1/1940th of an inch.

In 1742, Benjamin Martin described an eye-piece micrometer which consisted of a screw having fifty threads to the inch. One end of the screw was pointed, while the other carried a hand which passed over a dial divided into twenty parts. This appliance doubtless gave fairly accurate results, and in a more or less modified form has appeared in later micrometers. Baker also credits Martin with a glass micrometer having parallel lines 1/40th of an inch apart, and placed in the focus of the eye-piece.

Geo. Adams, Sr., in his *Micrographia*, 1746, says that, acting upon the idea suggested by Jurin, he constructed a micrometer which consisted of small silver wires stretched in the form of a lattice, the distances between the wires being equal to the diameter of the wire, which was probably from the 1/500th to the 1/600th of an inch. This lattice was used upon the stage, being placed under the object if it was transparent and over it if opaque. Adams, however, appreciated the difficulty of measuring objects which were less than the diameter of the wire.

Three years prior to Adams' publication, Baker described a similar arrangement invented by a Dr. Smith, consisting of a lattice of fine wires or small squares drawn upon glass with a diamond. This, however, was designed as an aid in drawing microscopic objects. According to Baker, Cuff devised a micrometer in 1747 which consisted of a lattice of fine wires 1/50th of an inch apart, set in a circular frame to be placed in the focus of the eye-piece. This device is shown in Fig. 1, Pl. XV. Baker made a similar micrometer of human hairs placed 1/10th of an inch apart, Fig. 2.

Geo. Adams, Jr., in his *Essays on the Microscope*, describes a needle micrometer which he states was first made by his father. This is shown in Fig. 3. It was designed to be clamped to the tube of the microscope, the needle passing through a small opening in the eye-piece. The screw had fifty threads to the inch, and was provided with an index moving over a circular plate

divided into twenty equal parts, so that each division of the scale indicated 1/1000th of an inch. The small prism, *a*, served to register the number of revolutions. Figs. 3, A, B, and C, show a sectoral scale used upon the stage to determine the actual value of the revolutions of the screw. It was two inches long, and 1/10th of an inch at the base. Hartnack devised a diagonal scale on the same principle, which consisted of fifty vertical lines crossed by two horizontal lines, whose distance apart equalled five divisions of the vertical scale, and which was crossed by a diagonal. Thus if the length of the vertical line was 0·5 inch, the shortest line on the lower side of the diagonal would be 0·01 inch.

Micrometers may be divided into two general classes :—First, stage micrometers, in which both object and micrometer are magnified together ; second, eye-piece micrometers, in which the scale is applied to the magnified image of the object. In the latter class the scale, or micrometer proper, is usually made a part of the eye-piece, so that the whole becomes a micrometer eye-piece.

Stage Micrometers.—These in their crudest form are represented by the sand grains of Leeuwenhoek, and the silver wires of Jurin. The micrometers of Coventry were made of glass, metal, ivory, etc., and bore lines ruled with a diamond at some uniform distance apart. The use of these micrometers for the direct measurement of microscopic objects was, of necessity, very limited, being confined to low powers where the object and scale could be brought practically to the same focus. In other ways, however, these micrometers are very important. Their use with the camera lucida and in standardising eye-piece micrometers is familiar to all microscopists. In the former case any object drawn can be measured by replacing the object by the micrometer, the conditions remaining the same. If the size of the object drawn is arrived at by dividing the size of the image by the magnifying power of the microscope, the distance from the eye-piece to the surface receiving the image must be ten inches.

More recently Zeiss has offered a stage screw micrometer, shown in Fig. 4. This is intended for the accurate measurement of objects too large for one visual field of the microscope, and can be adapted to the stage of any of the larger stands. The plan of this micrometer is sufficiently evident from the illustration. The

small dial registers complete revolutions of the screw, the fractional parts being indicated by graduations on the larger disc, whose smallest divisions are equivalent to ·002 mm. The screw measures up to 10 mm., or nearly ·4 inch.

Micrometer eye-pieces.—These may conveniently be divided into those with fixed scale and those with movable scale. The eye-piece may be either positive or negative, the former giving the best view of the micrometer, and the latter of the object.

In micrometers with fixed scales, the lines may represent fractional parts of a millimeter or of an inch, or, as is usually the case, be some arbitrary scale, the value of which must be determined for different combinations of objectives, oculars, and tube length. The scales ruled on glass in the form of squares, and which are copied from the lattice micrometers of the older microscopists, are not to be recommended for general work, although they are sometimes used in special cases.

In 1840, Geo. Jackson devised an improved form of Martin's eye-piece micrometer. The scale was on glass and mounted in a metal frame, with a screw at one end and a spring at the other. The eye-piece, a negative one, was provided with slits to allow the scale to be moved across the field. The arrangement is shown in Figs. 5 and 6, the former being the micrometer, and the latter its position in the eye-piece.

The method of using this micrometer is familiar to most, but for the benefit of others it may not be out of place to give one method, especially as the same applies to other ocular micrometers. It is first necessary to standardise the eye-piece micrometer. This is effected by bringing the scale into focus, placing a millimeter or inch micrometer upon the stage, focussing, and then adjusting the two scales so that the zero of the eye-piece scale shall exactly correspond with one of the lines of the stage micrometer. Determine how many divisions of one are equal to an even number of divisions of the other, when a simple calculation will give the value of each division of the ocular scale in terms of the stage micrometer. Thus, suppose that 0·5 mm. of the stage micrometer are equivalent to forty-six divisions in the eye-piece, each division of the latter is therefore equal to 0·01087 mm. Replacing the stage micrometer by the object to be measured, it is found that its length is equal to

thirty of these divisions, or in other words is 0·326 mm. in that dimension. It is obvious that this value for the divisions of the eye-piece micrometer is good only while the conditions remain the same.

The form of micrometer eye-piece devised by Jackson has been largely replaced by one in which the scale, an arbitrary one, on a circular glass is fixed at the focus of an ordinary negative eye-piece. The micrometer eye-pieces with movable scales are represented by the cobweb micrometer invented by Ramsden, and first used for telescopes. Fig. 7 shows the eye-piece, and Fig. 8 the cobwebs and comb.

It consists of a positive eye-piece, in the focus of which two fine parallel wires or cobwebs are stretched across the field. One of these wires is fixed at the centre of the field, while the other can be moved by means of a screw, having fifty or a hundred threads to the inch, and whose outer end is attached to a graduated disc, usually divided into a hundred parts. On the lower side of the field is a metal comb having notches which correspond with the threads of the screw. This comb serves to register entire revolutions of the screw, while fractional parts are indicated by the disc. It is necessary to ascertain the value of each revolution or part of a revolution of the screw in the manner already described. The objection to this micrometer is that the measurement of an object cannot be made in the centre of the field.

Among other modifications of this micrometer is one by Nelson, in which the fixed wire was placed five notches from the centre of the field on the side furthest from the screw head; and later the same microscopist still further improved it so that both wires could be moved *en bloc* across the field, and also by adopting a compensating eye-piece.

Zeiss has devised a screw micrometer eye-piece for objects which occupy a large part of the field. It consists of a Ramsden eye-piece having a glass-plate with crossed lines, and the whole can be moved across the field by means of the micrometer screw. A compensating eye-piece can be employed instead of the Ramsden for use with apochromatic lenses.

The ease and accuracy of measuring objects by means of photomicrography is familiar to all who have had experience with

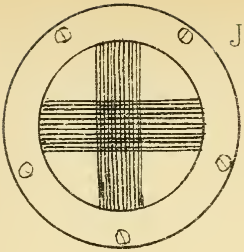
this method. We believe Dr. Woodward preferred this to all others for the measurement of blood corpuscles. By substituting the stage micrometer for the object its image is thrown upon the ground glass, and then can be measured or photographed as desired. Measurements should be made upon the negative and not on the positive print obtained from it.

Regarding the unit of measure to be adopted in micrometry, it may be said that the micron, or the 1/1000th of a millimeter, is now generally adopted in scientific work. The standard was proposed by Harting in 1859, who called it a micro-millimeter. This term was afterwards changed to micron by Listing, and the sign μ adopted as an abbreviation. The micron is equivalent to nearly 1/25,000th of an inch. The determination of the magnifying power of a microscope is effected in much the same way as the measurement of microscopic objects.

One of the simplest plans is that suggested by Hooke, to which reference has already been made. If a stage micrometer is used in place of the object a comparison can be readily made between the image of any portion of the scale and the ruler placed at the same distance. Thus if 1/100th of an inch on the stage micrometer is equivalent to 6/10ths of an inch on the ruler, the magnification is sixty diameters.

Another simple and accurate method is to use some form of the camera lucida. The microscope is arranged as for drawing, the paper being placed ten inches from the eye-piece. It is important to note that in *measuring* objects by the camera lucida it is immaterial what this distance is, since the object bears the same ratio to the scale at all distances. A micrometer is then placed upon the stage, and its graduations projected upon the paper and measured. The magnifying power is found by dividing the distance measured on the paper by the division of the stage micrometer used. Thus, if 1/100th of an inch of the scale equals three inches on the paper, then the magnifying power is 300 diameters.

Other methods have been suggested, but they possess no advantages over those given.



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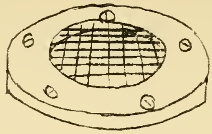

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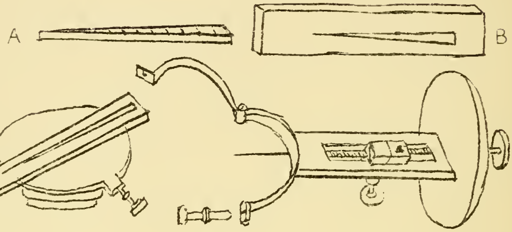

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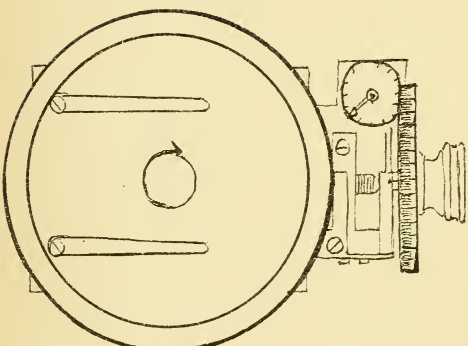

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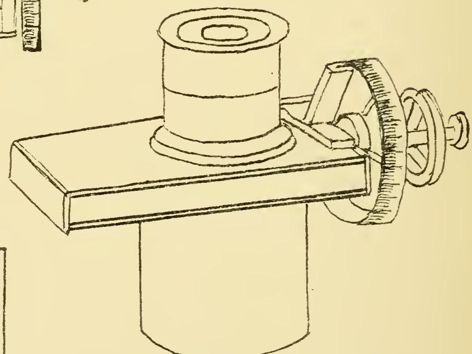

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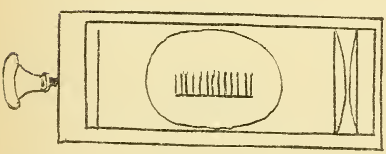

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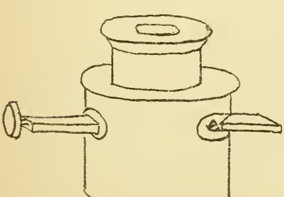

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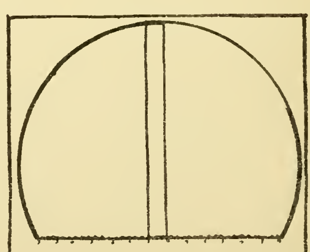

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EXPLANATION OF PLATE XV.

Fig. 1.—Cuff's Wire Micrometer.
,, 2.—Baker's Hair Micrometer.
,, 3.—Adam's Needle Micrometer. *A*, *B*, *C*, the sectional scale.
,, 4.—Zeiss' Stage Micrometer.
,, 5.—Jackson's Eye-piece Micrometer.
,, 6.—Jackson's Micrometer Eye-piece.
,, 7.—Ramsden's Micrometer Eye-piece.
,, 8.—The scale of the same.

On the Reproduction of Orbitolites.*

By J. J. Lister, M A.

MR. H. B. Brady has described specimens of Orbitolites which he obtained in Fiji, showing the margin of the disc crowded with young shells. Mr. Brady's material was worked at in the dry state, and it was at his suggestion that the author collected specimens, preserved in spirit, from the Tonga reefs. Examination of this material shows that large brood-chambers are formed at the margin of the disc during the later stages of growth. These are, at first, lined with a thin layer of protoplasm. At a later stage the central region of the disc is found to be empty, and the whole of the protoplasm is massed in the brood-chambers in the form of spores. The spores have the structure of the "primitive disc," which, during the early stages of growth of the Orbitolites, occupies the centre of the shells. They are liberated by absorption of the walls of the brood-chambers, and each becomes the centre of a new disc, which is built up by additions of successive ridges of chamberlets at the margin. The reproduction of Orbitolites, therefore, takes place by spore formation.

The spore contains a single nucleus, lying in its "primordial chamber." After several rings of chamberlets have been added, a stage is reached at which the nucleus appears to be represented by numbers of irregular, darkly staining masses, scattered through the protoplasm of the central part of the disc.

In the later stages, numbers of oval nuclei are found in the protoplasm, often arranged in pairs, and in favourable preparations they may be seen to be undergoing amitotic division.

* Extracted from the *Proceedings of the Cambridge Philosophical Society* by G. H. Bryan.

Technology of Diatoms.*

By Mons. J. Tempere.

Conclusion.

The Selection—The Mounting of Isolated Specimens and Systematic Preparation.

A COLLECTION of Diatoms to be really useful, so that it may serve as a means for comparing species—their affinities, transformation, etc., etc.—ought to be as much as possible of isolated, well-marked individuals, so as to be capable of being classed in a systematic manner.

At first it seems very difficult to be able to take hold of and transfer microscopic bodies so small as the greater part of the Diatoms, and yet it can be attained with less effort than might have been supposed. Certain arrangements, and a little practice and patience, will suffice, as we shall presently see.

The deposit and gathering, washed and held in suspension in very pure distilled water, are spread either on microscopic slips or on cover-glasses that serve to support them. If cover-glasses are used, I give the preference to those of from 15 to 18 mm. diameter, No. 2, that is to say, rather thick, which when once covered with Diatoms can be preserved, if they are deemed suitable, in little boxes of 17 or 18 mm. diameter, and separated one from the other by rings of caoutchouc or of card, which can be easily obtained.

If the spreading be made on micro-slips, which I prefer, they ought not to exceed from 18 to 20 mm. to the centre; then these slips may be placed one on the other, separated by small pieces of gummed card fixed at the end of each slip.

To conduct the selection under the most favourable condition, and without risk of confounding the species, it is necessary to use an optical combination, giving at the same time an enlargement of from 80 to 100 mm. in diameter, and a focus long enough to allow the operator free manipulation of the instruments by which he takes hold and transfers the Diatoms. The longer the focus of the lens,

* Translated from *Le Diatomiste.*

the greater the ease of the operator. As to the eye-piece a No. 3 ought to be sufficient, otherwise the eye will be too quickly tired; the rays reflected from the mirror of the microscope will give light enough; an iris diaphragm is useful for moderating the light. When the light is too intense, I use a piece of clear blue glass fixed under the stage of the instrument, to soften it still more, the work of selection being trying to the eyes, especially when it is continued for many consecutive hours.

In a combination of this kind, there is yet one difficulty to overcome—namely, the reversal of the image of the object. The employment of a correcting eye-piece takes away too much light and definition; besides, it fatigues the eye more, so I advise our readers to neglect this, for they will actually become, and that in a very short time, so accustomed to this optical effect that they will not notice it, or, at all events, that it will not inconvenience them.

It is the same in the use of the mechanical finger, and of all other contrivances more or less ingenious intended for picking up Diatoms. In my opinion, the hand is the only sure instrument, and in a relatively short time it is possible to acquire sufficient steadiness. I recommend the use of very simple instruments. The bristle of a living hog, or of one recently killed, or better still a hair from the belly of a hedgehog, carefully chosen by means of a pocket lens, fixed with wax to the end of a light pen-holder, or held within the jaws of a light drawing-pen, constitutes the instrument.

I prefer using a drawing-pen to anything else, because then it is easy to lengthen or shorten the hair according to the requirements of the occasion. You can hardly understand, when we have got a really good bristle, how careful we are of it.

I pass on to notice the little incidents that may happen during the selection.

The Diatoms jump and pass out of the field of vision on contact with the bristle.

There are two causes for this :—First, the distilled water has not been perfectly pure, or possibly the Diatoms have not been sufficiently washed; in these cases the valves adhere more or less to the glass, and the bristle, in suddenly detaching them, makes

them jump in a manner that is not pleasant to the operator. Second, the bristle has touched the Diatom too much on one side, and according to its shape has made it take a half-turn, accompanied by a jump.

To avoid these, it is necessary, in the first case, to cause the valve to slide very smoothly before the bristle, sometimes breathing softly on the plate and not lifting the valve till it is free; and in the second case, which is the more frequent, only touching the Diatom on the centre, which is what you always ought to do.

The Diatoms stick to the Bristle.

I have said, in speaking of the choice of a bristle, that it is needful that it should be taken either from a *living* animal or from one recently killed. Under these conditions, preserving its natural fatty condition, it remains supple and the objects adhere to it more willingly. It will be enough to pass the bristle through the lightly-closed lips to make it sufficiently moist to hold the Diatoms, and at the same time to remove any particles of dust that may be adhering to it. When the valves do not easily leave the bristle, it is that a little saliva remains on the end of it, or perhaps that the extremity presents some accidental roughness, in which case it becomes necessary to change it; lastly, this tiresome adherence may equally proceed from a cause that I attribute to an electric current—a curious fact, but one well known to those who have selected Diatoms. Mr. Kinker, of Amsterdam, has told me that when the north wind blew rather strongly, the effect was very sensible. I have observed the same many times. This is not always the sole cause; but each time that an effect of this kind has been produced, I have laid aside my selection for a more propitious moment.

When a Diatom has been chosen, it must be transferred to a slip prepared to receive it, and there fixed. For this it is needful to use two microscopes, the second serving to centre the slip carrying the prepared cover-glass; but then there is some chance of losing the object *en route*, especially if it be heavy. It is therefore better to place the two slips side by side on the stage of the microscope which is used for the selection, and then advancing

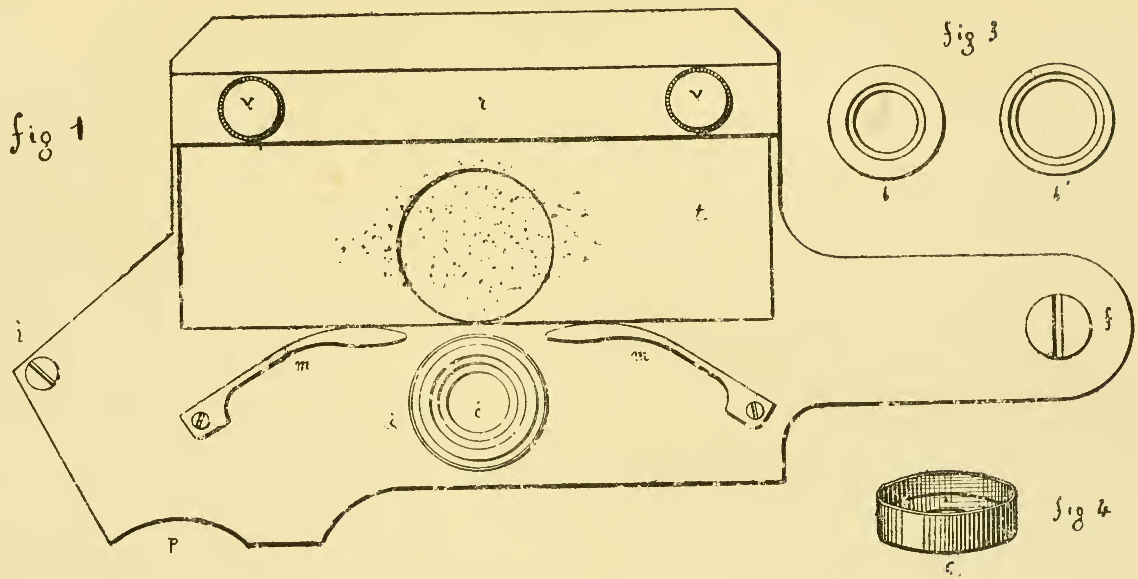


Fig. 20.—*a*, A metallic box to receive the diaphragm, *b*, *b* (Fig. 3), and a cover with glass top, *c*, Fig. 4), for cover-glasses 10 or 12 mm. in diameter, prepared to receive the selected diatom ; *t*, Slip carrying the supply whence the selection is made ; *r*, Bar to keep the slip in place ; *m*, *m*, Springs which, acting against *r*, hold the slip fast ; *v*, *v*, Screws for clamping the bar in place ; *f*, Axis of movement ; *p*, Part cut away, on which you place the thumb of the left hand to push the stage forward ; *i*, The part on which the forefinger of the same hand rests to bring it back to its first position.

or withdrawing both together, the desired part of each can be brought under the objective.

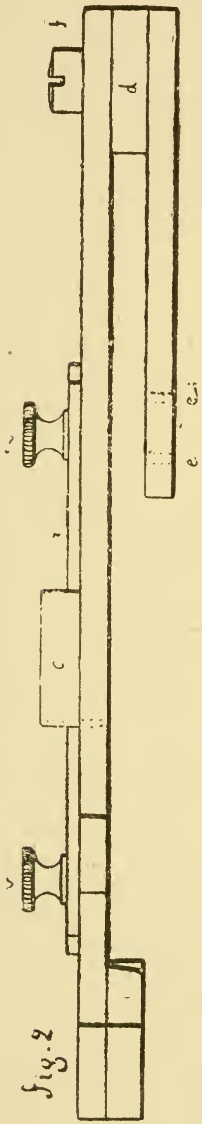


Fig. 21.—Vertical view of the movable stage, showing on the right the part which is fixed on the microscope stage; *e*, *e*, Screws fixing the two stages together.

This mode of operation suffices when you are making preparations of isolated specimens, but when you are making systematic preparations, that is to say, when groups of a certain number of species, classed in a certain order, are to be made, the use of a movable stage is absolutely necessary.

I give a sketch of a stage of this kind which I have constructed, and which has done me good service. In this stage, the height of the box carrying the hollowed rings for holding the prepared cover-glasses is so arranged that the surface of these is on the same level with that on which the Diatoms are spread, and this prevents any change of position, however long the work may have to be continued.

Cements used for fixing the Diatoms on the Cover-glasses.

The liquids or cements used for fixing the Diatoms are of various kinds. Some of them change as they grow older, and lose, if not totally, at least a part of their adhesiveness. Gum-lac is of this class. In general, the cements present a dry surface, from which it is possible to remove dust that may have accidentally fallen on it—such are certainly preferable to all others.

The composition of those most commonly used is as follows:

Gum-lac Cement.—Dissolve a small quantity of white lac in alcohol of 90 per cent., making the solution of such strength that a drop spread on a slip, slightly warmed, leaves a film of lac very thin and transparent. This solution ought to be filtered after resting, so that the insoluble and flocculose portions may subside. As the solution is alcoholic, it spreads spontaneously and evenly over the slip. It is sufficient to place in the centre a small drop by means of a small glass pipette; the only precaution that is absolutely necessary to be taken, if you wish to get an even and transparent surface, is slightly to warm the slips before putting the cement on them.

Gelatine and Fish-Glue Cements.—These two cements are very good, especially the second; the preparation is as follows:—

Russian Isinglass, or extra-white Gelatine -	1	gramme.
Phenique, Distilled Water, as 1 to 100 -	100	,,
Acetic Acid (crystallisable) - - -	1	,,

Steep the gelatine or isinglass for an hour or two in the water; then dissolve by the application of heat; filter, while hot, through a simple filter-paper, and then a second time, while still hot, through a double or triple filter; then add the acetic acid, the object of which is to make the solution quite clear and to maintain it in a liquid state.

Resinous Cements.—The solutions already described on pp. 268—271 can be used with equal success.

For Fixing the Diatoms on the lac, it is necessary to slightly warm the slips on which they are placed; for the other three, it will be enough to breathe softly on them.

For the more convenient preparing of the cover-glasses, I fix them temporarily on a slip by breathing strongly on it and then rapidly slipping the cover-glass on this humid surface. Nine times out of ten the cover-glass adheres sufficiently to allow of its being perfectly cleaned; it is covered with the fixing liquid, and the slip serves to support it while you are placing the objects upon it; after which a slight exposure to the flame of a spirit-lamp will separate the cover-glass from its support.

Cells.—When large Diatoms are to be mounted separately, especially those with long, fragile appendages, the use of a cell becomes a necessity. The most simple method is this:—You prepare a solution of gum arabic as thick and as pure as possible. The water employed to dissolve the gum should previously be deeply coloured with some aniline dye; then, by means of a turn-table, you make on the centre of the cover-glasses already cemented a little cell from 1 to $1\frac{1}{2}$ mm. interior diameter, and about 1/10 mm. thick, and leave it to dry perfectly. The other kinds of cells are less useful and more difficult to make, requiring the use of costly instruments.

Artistic and Systematic Preparations.

These preparations, which certainly are very beautiful when well done, call for much skill on the part of the operator. The use of a movable stage then becomes indispensable. To enable you to place the objects regularly at equal distances at right angles or in curves, you use glasses divided into 1/10 mm., which are placed in the eye-piece (Figs. 22 and 23). Fig. 23 helps to make those pretty rosettes, which certainly the greater part of our readers have admired.

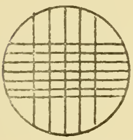


Fig. 22.

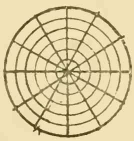


Fig. 23.

We beg to thank Mons. J. Tempère for the use of the blocks by which this and the previous paper are illustrated.—*Ed.*

Distribution of Fungi by Snails and Toads.—Voglino communicates a suggestive paper to the *Nuovo Giornale Bot. Ital.* (1895, 181), in which he demonstrates that certain fungi (*Agaricinicæ*) are distributed by snails and toads. An examination of the stomachs of the snails showed the presence of the spores of various species of fungi which were seen to have begun their germination, and culture experiments with the excrements of various snails produced a large number of germinating spores of fungi. The same was observed on examining the stomachs of toads, in which the spores of *Russula* and *Lactarius* were specially abundant.—*Pharmaceutical Journal.*

On the Formation and Structure of Dental Enamel.*

Plates XVIII., XIX., XX., XXI.

By J. Leon Williams, D.D.S. Baltimore, L.D.S., R.C.S.I.

ALMOST every anatomist or histologist of note since the time of John Hunter has made some contribution to the subject of this paper. In going over the literature of the theme, one is struck by the wide divergence of opinion expressed—a divergence which is as marked and emphatic to-day as it was forty or fifty years ago. Broadly speaking, all who have written on the subject may be separated into two groups or schools: those who have taught that the formation of enamel is effected by direct cell-calcification, and those who have claimed that the tissue is produced by a secretion—by the calcification of a cell product. Between 1850 and 1860, Professor Carpenter was maintaining the former position, and during the same time the late Professor Huxley wrote several papers antagonising this view, and claiming that enamel could not be produced by any conversion of a cellular structure. Curiously enough, his main contention was correct, although founded upon mistaken premisses. In 1848, the late Sir John Tomes delivered a course of lectures in which he taught that enamel formation is the result of the calcification of the enamel-forming cells. His son, Mr. Charles Tomes, in the last edition of his work on Dental Anatomy, published in 1894, still holds to this opinion; and these views are also shared by Waldeyer, Wedl, and many others. On the other side, Professor Schäfer in England, Professor Spee in Germany, and Dr. Andrews and Dr. Sudduth in America, have maintained that the enamel cells or ameloblasts are not directly calcified, but that they are the active agents in producing the material from which enamel is formed.

It is not my intention to present a summary of the history of the literature of this subject, and I have mentioned the foregoing names merely to show that the most eminent teachers have held,

* An abstract of a paper read before the Royal Society, December 12th, 1895. From *The Lancet*. We beg to thank the editor for kindly lending the blocks which form the accompanying plates.

and still hold, widely different views. This difference, I believe, has largely grown out of relying too closely on one or on a few particular methods of working. I have seen many illustrations of the possibility of drawing contradictory conclusions from appearances presented by different methods of treating tissues, each of these conclusions very probably representing a half truth. Another reason may also be found in the very great difficulties attending the preparation of thin sections of developing teeth with all of the tissues in their normal relations. In deciding, therefore, to reinvestigate the whole field of the development of the teeth, I determined at the outset to adopt a large number of methods of working, in the hope that, by comparing the results of widely differing treatment, I might unravel some of the tangles in which the subject has always been involved. I selected for the commencement of my work embryos of the cat, dog, sheep, cow, hog, and monkey, as well as human embryos of all stages of development. The rodents were also represented by mice, rats, and guinea-pigs. Some of the material was cut while fresh, and some immediately after fixing by freezing processes. Other material was fixed and hardened by a great variety of processes, and embedded in balsam by the Weil process, or decalcified by different acids and embedded in paraffin and celloidin.

More than thirty different stains and combinations of stains have been tried, and sections have been mounted in balsam, Farrant's medium, glycerol, sulpho-carbolate of zinc in glycerol (my favourite medium for purposes of study), and other preservatives. As there is but little difference of opinion concerning those earlier stages of tooth development which precede the commencement of the formation of dentine and enamel, we need give no further attention to this period than is necessary for an introduction to the subject proper. All students of dental histology are now aware that the teeth are developed from two distinct tissues. The so-called enamel organ is a product of the oral epithelium, while the dentinal germ or papilla is formed in the submucous or dermal tissues, the former being the first to appear.

The first sections cut for these special studies were from the jaw of an embryo lamb at a period just after the commencement of enamel formation. The material was fixed in a saturated

aqueous solution of corrosive sublimate, partially decalcified in a weak solution of chromic and nitric acids, and embedded in paraffin. Sections were stained with a modification of the Ehrlich-Biondi fluid. The appearances were different from anything I had before seen. There was no trace of a prismatic character in the partially decalcified enamel, but instead a faint appearance of fibres running parallel with the inner ends of the ameloblasts, with small globular masses irregularly distributed among them.

Fibrous Character of Enamel.

With the suggestions which this specimen gave me, I prepared some extremely thin sections from the persistently growing incisor of the rat. The enamel rods in the enamel of the rat, as is well known to those who have studied the subject, terminate a little below the surface, leaving on the outside a thin layer of clear and apparently structureless enamel. A partial decalcification of this layer showed a stroma composed of two sets of fibres running in nearly opposite directions, neither direction corresponding with the long axis of the ameloblasts. One set of fibres passes in a somewhat more oblique course than the other, and becomes confluent with the ends of the enamel prisms. The other set of fibres sweeps downward on a circular course, crossing the more oblique-running fibres and the enamel prisms nearly at right angles. Sometimes both sets of fibres join, and, twisting about each other in a rope-like design, pass along the course of the enamel prisms (Fig. 1). It is probable that the arrangement of fibres is fairly constant in teeth of the same animals, although differing widely in teeth of different animals; but it is only by cutting sections in a great variety of directions that one at last gets a true picture of the complex arrangement of fibres and rods. Enamel from the teeth of rats and mice shows a more marked fibrous character than any other that I have examined, and the most striking feature of arrangement of the fibre is the interlacing or weaving together of those running in different directions, like warp and woof in a web. This is very plainly shown in Fig. 2, where the torn edge of the enamel bears a striking resemblance to the effect produced by tearing a woven fabric of any sort.

Structureless Basement Membrane, or Membrana Præmaformativa.

By means of selective stains I have been able to demonstrate the existence of a membrane-like structure lying between the ameloblasts and the forming enamel, and also between the ameloblasts and the stratum intermedium. It is uncertain whether this structure is identical with the membrana præmaformativa of Raschow, Huxley, and others. Its existence has been disputed by several of the more recent writers upon this subject; but it is plainly shown in Figs. 3, 4, 5, 6, and 7. I suggest that the structure lying between the ameloblasts and the stratum intermedium be called the *outer ameloblastic membrane*, while that which separates the enamel cells from the forming enamel may be known as the *inner ameloblastic membrane*.

The Cells of the Stratum Intermedium.

It has for many years seemed clear to me that the enamel organ, and more especially the cells of the stratum intermedium, should be classed among the true secreting tissues. I am not able to understand how so many good observers have failed to see the intrinsic plexus of blood vessels, which is very early developed in this layer of cells. Wedl, Magitot and Legros, Sudduth, and others say that they have uniformly failed to detect a blood supply within any part of the enamel organ proper. If we examine the evolution of this tissue in the enamel organ of the mouse or the rat, its place among glandular structures at once becomes evident. All appearance of round, polygonal, or oblong cells, as usually seen in the stratum intermedium, has entirely disappeared, and in their place we have a highly differentiated secreting tissue. The ameloblasts are surmounted by epithelial papillæ, around and between which is a free distribution of capillary loops. The ameloblasts are seen to be in intimate relation with the papillæ, each ameloblast seeming to have a root-like process which extends into and is lost in the substance of the papilla to which it belongs. The diameter of each papilla is equal to about that of five or six ameloblasts, and each papilla may therefore be said to supply from twenty to twenty-five ameloblasts. Blood-vessels are seen, in both transverse and longitudinal section, everywhere about the papillæ, and we may often observe branches

descending to supply the loops which pass round the ends of the papillæ lying next the ameloblasts (Fig. 2).

At the commencement of enamel-formation in the teeth of the mouse there is but little indication of a special secretory organ, as may be seen by referring to Fig. 4. We see here that the outer ameloblastic membrane is not structureless, but is apparently composed of very fine fibres.

Method of Formation of Enamel.

Several observers of distinction—notably Dr. R. R. Andrews and Professor Spee—have described the development of enamel as a process in which the tissue is formed by the deposit of droplets or spherules of calcoglobulin. This view is undoubtedly correct, but, as stated by the writers mentioned, it does not include all the phenomena that may be observed. The ultimate structure of completely formed enamel shows that it is built up by the deposit of bodies which are of very nearly uniform size. There is, as we shall see, no uniformity in the size of these masses of calcoglobulin, neither is there anything in their structure which corresponds with that of formed enamel; in fact, under the finest lenses that are made they show as highly refractive masses without definite structure. Although they are usually more numerous at the inner ends of the ameloblasts, next to the forming enamel, they may be seen throughout the entire length of these cells, and I have often seen them lying close up to the membrane which separates the ameloblasts from the stratum intermedium. Occasionally I have espied them when they seemed to be actually in, or emerging from, this membrane. Such appearances are shown in Fig. 5. It is possible, and I think highly probable, that this substance, although appearing in the ameloblasts, is really formed in the more specifically secreting cells of this stratum intermedium. These masses probably consist of calcoglobulin, an albumin-like substance holding calcific material in solution. Its function, I believe, is not the building up of the enamel rods as has heretofore been supposed, but the formation of the interprismatic or cement substance which binds the enamel rods together.

It is clearly shown in Fig. 6 that the enamel rods are formed by the superposition or continuous deposition of bodies which are spherical when they leave the enamel cells, but by compression or

chemical action are more or less changed into a disc-like shape as they take their place in the building of the enamel rods. Thus, for the first time, we have a clear explanation of the varicose appearance of the rods or prisms in completely-formed enamel. Each varicosity of the rods represent one of these globules or disc-like bodies. In the inner portion of enamel next to the dentine the enamel globules usually melt together so completely that their individual form is lost, but as we approach the outer surface of the enamel the rods are clearly seen to be composed of globular or flattened bodies, not completely united, but still connected by calcified plasmic strings. These plasmic strings, of which there are many to each enamel rod, are often seen under a power of from 800 to 1000 diameters to be made up of granules, and these granules, so far as our present powers of observation are concerned, constitute the ultimate structure of enamel.

The Cross Striæ and Retzius Bands.

My observations on these points have led me to totally different conclusions from those reached by Professor von Ebner of Vienna. Professor von Ebner regards the striæ of the enamel rods as an artificial appearance produced by the action of acids, and the Retzius bands as due to ground-off or artificial prism ends, and also to imprisoned air or gas contained in minute tubes or canals.

I have clearly demonstrated that the cross striæ are due to the varicose enlargements of the enamel rods, and that these varicosities are produced by the successive deposit of globular masses from the enamel cells. The deposit of these bodies is simultaneously over the entire surface of the forming enamel, hence the regularity of the lines of striation and increment. I have further shown that the Retzius bands cannot be due to air or gas in minute canals, because there are no such canals in normal human enamel. Neither are these bands due to the ground-off ends of enamel rods, as may be clearly seen from Fig. 8, where the rods are seen to pass through several bands without break in their continuity. The Retzius bands are caused by pigmentary matter in the granules which constitute the ultimate structure of enamel. Completely formed normal human enamel contains no living matter in the sense in which this term is generally understood. There are consequently no nutritive changes in enamel after it is once formed.

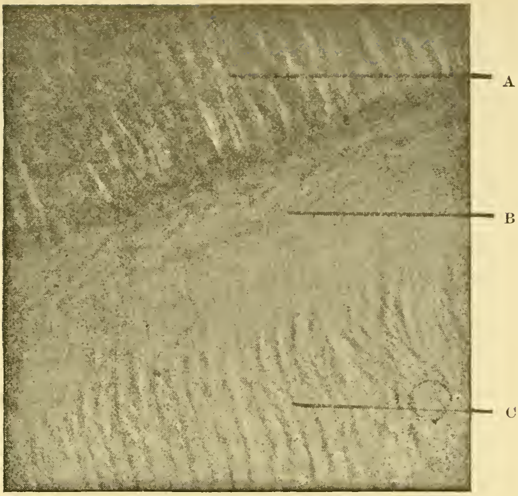


FIG. 1.

Forming enamel from incisor of rat. × 800. A, Enamel cells. B, Outer fibrous layer of enamel. C, Enamel rods showing twisted fibres.

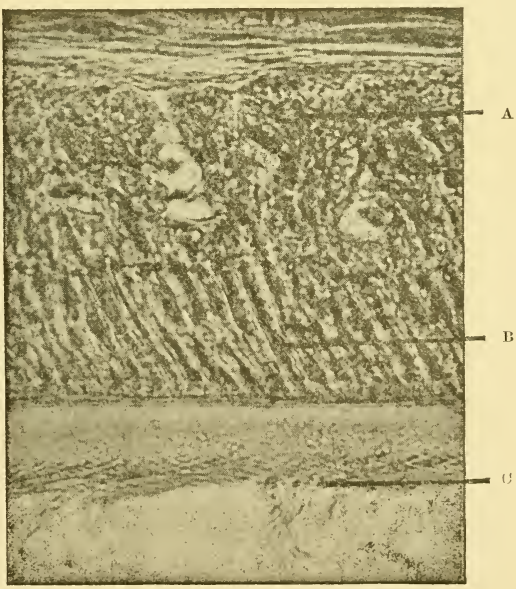


FIG. 2.

Forming enamel of rat. × 400. A, Secreting papillæ of enamel organ. B, Enamel cells. C, Torn fibrous edge of enamel.

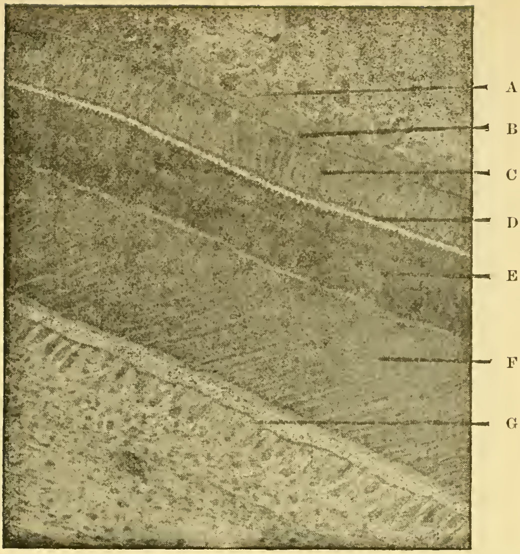


FIG. 3.

From longitudinal section of developing tooth of lamb. × 150. A, Secreting cells of stratum intermedium. B, Outer ameloblastic membrane. C, Ameloblasts or enamel cells. D, Inner ameloblastic membrane. E, Enamel. F, Dentine. G, Odontoblasts.

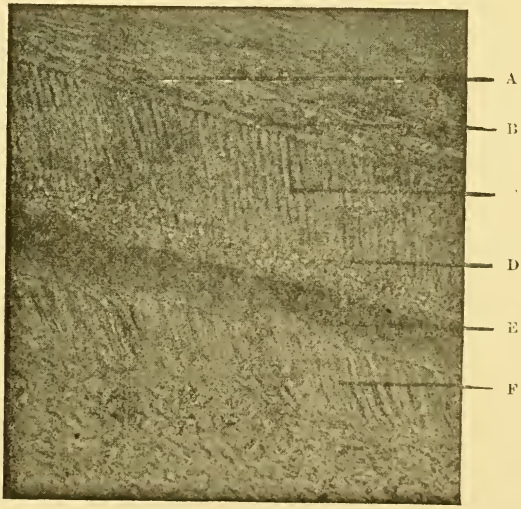


FIG. 4.

Section of developing incisor of mouse. × 400. A, Cells of stratum intermedium, from which secreting papillæ are developed. B, Outer ameloblastic membrane. C, Ameloblasts. D, Formation of enamel by deposit of globular bodies from enamel cells. E, Dentine. F, Odontoblasts

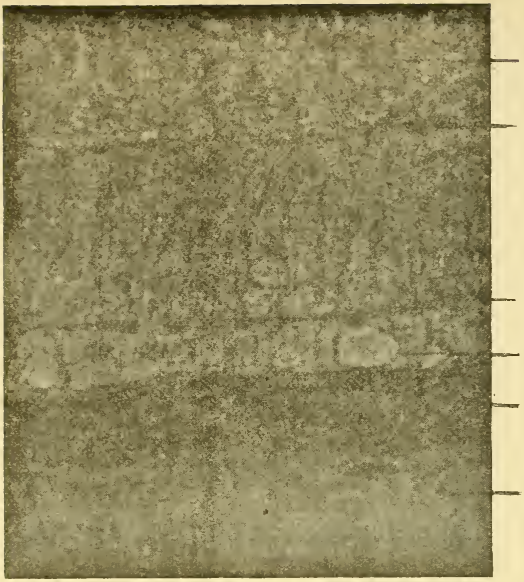


FIG. 5.

Formation of masses of calcoglobulin in enamel organ of lamb's tooth. × 800. Stratum intermedium. B, Outer ameloblastic membrane. C, Inner ameloblastic membrane. D, Calcoglobulin masses. E, Enamel globules from which enamel rods are formed. F, Dentine.

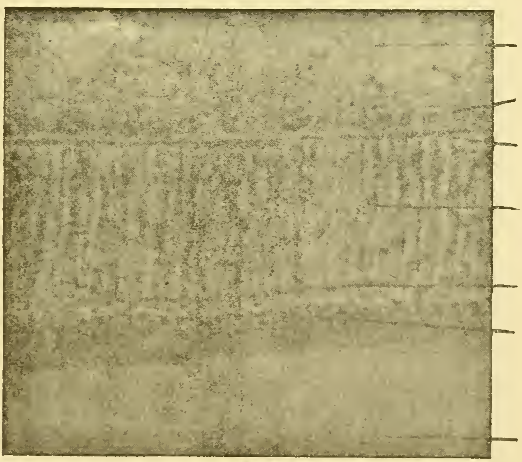


FIG. 6.

Section of developing tooth of human embryo. × 600. A, Reticulum of enamel organ. B, Stratum intermedium. C, Outer ameloblastic membrane. D, Ameloblasts. E, Inner ameloblastic membrane. F, Formation of enamel rods by successive deposit of enamel globules. G, Dentine

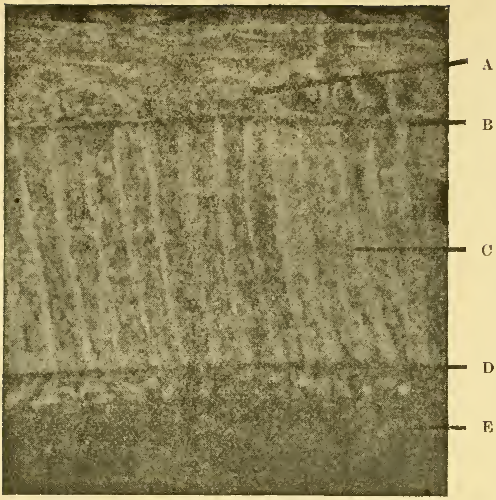


FIG. 7.

Section of developing tooth of dog. × 1000. A, Stratum intermedium. B, Outer ameloblastic membrane. C, Ameloblasts showing small masses of calcoglobulin. D, Inner ameloblastic membrane. E, Enamel.

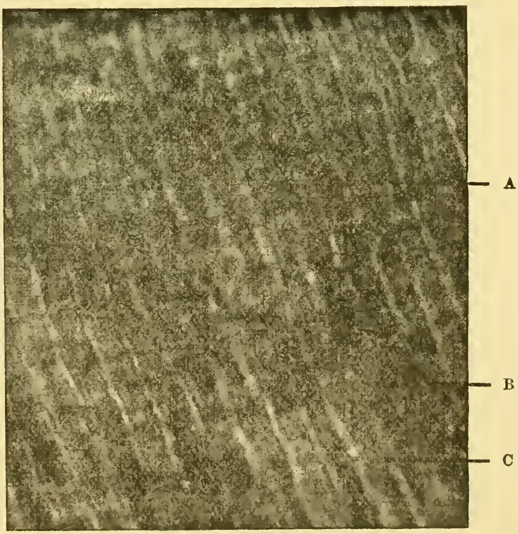


FIG. 8.

Human enamel. × 1,000. A, B, Bands of Retzius. C, Enamel rod passing through bands without break of continuity.

Predacious & Parasitic Enemies of Aphides
(including a Study of Hyper-Parasites).

By H. C. A. Vine.

Part IV. (concluded) and Part V.

Plates XIII. (July Part) and XVII.

WHEN completing the drawings for the last part of the section on *Heteroptera*, some observations led me to think it probable, and indeed almost certain, that another group of this sub-order includes aphis-eating species, and I included, therefore, in Pl. XIII., a drawing of the only European species, the *Podisus luridus* of Fabricius. This insect is one of the family, *Pentatomidæ*, and in common with other species of that group, in the larval form, has four joints only in the antennæ, while the perfect insect possesses five joints in these organs.

The majority of the species of this family are inhabitants of the United States, where the favourable surroundings have caused a development of the Hemiptera much beyond any that obtains in Europe, and it was an account given by Professor Riley of the attacks of several species, and in particular *P. spinosa*, upon the larva of the Colorado Beetle (*Doryphora 10-lineata*, Say), which led me to suspect that some varieties of the family would prove to be aphidivorous. I have since observed that in captivity the species figured will occasionally destroy small, soft insects, and among others aphides, and in view of these facts it may prove of interest to include here some account of the one European species and of the best known of the American varieties.

The former—*Podisus luridus*, Fabr.—is figured on Pl. XIII. at Fig. 11, and it bears a strong resemblance to the genus *Tropicornis*, from which the mature insect may be distinguished by its much shorter and stouter rostrum, and in general by the comparative shortness of the antennæ. The colour of the mature insect is dull yellow, ochreous, to brownish, showing a considerable amount of green opalescence or reflection, which becomes the prevailing colour of the head. The margins of the thorax are distinctly green, while the yellowish scutellum is pretty closely punctured

with dark depressions, generally green also. The elytra, thorax, and head are all thickly and deeply punctured in a manner which frequently gives a mottled appearance to specimens. The membranous portion of the hemelytra is smoky, and the whole effect of the colouring is somewhat dull, unless in an oblique light, when the green and purple iridescence overcomes the duller lines.

The tarsi are black, the legs yellowish brown with dark blotching, and the tibiæ of the anterior pair are spiny. The posterior edges of the thorax are produced laterally in a very remarkable way.

The American variety of this genus, which I have mentioned as probably—in fact, pretty certainly—aphidivorous is described by Professor Riley as *Arma spinosa*, Dallos, and is known in the United States, which is its chief habitat, as the 'Spined Soldier-Bug.' It, however, belongs to the modern genus, *Podisus*, and—although, so far as I am aware, it is not found outside America—the possibilities of transit are so great that it is pretty certain to be sooner or later found on this side of the Atlantic, and in this event will doubtless make Aphides one of its chief sources of sustenance.

Professor Riley, who has made special study of the natural enemies of the Colorado Beetle, gives the following particulars concerning this species:—"This is one of the most common and efficient of Doryphora's enemies, occurring in all parts of the country, and seeming to have a decided fondness for our potato-destroyer, especially for the soft larva. It is of an ochre yellow colour. Thrusting forward his long and stout beak, he sticks it into his victim, and in a short time pumps out all the juices of its body and throws away the empty skin. He belongs to a rather extensive group (*Scutellera* family) of the true bugs (*Heteroptera*), distinguishable from all others by the very large scutel, which in this genus is triangular and covers nearly half the back.

"The Spined Soldier-Bug may be at once distinguished from all allied bugs, whether plant feeders or cannibals, by the opaque brown streak at the transparent and glassy tip of its wing-cases. The eggs of this Soldier-Bug are pretty little, bronze-coloured, cauldron-shaped objects, with a convex lid, around which ciliate fifteen or sixteen white spines. They are neatly placed side by

side in clusters of a dozen or more upon leaves and other objects, and are so much subject to the attacks of a minute Hymenopterous parasite, that those who undertake to hatch such as are found outdoors, will more often get flies than bugs. The newly-hatched bug is ovoid and shiny black, with some bright crimson about the abdomen. In the full-grown larva the black still predominates on the thorax, but some four yellowish spots appear, and the abdomen becomes more yellowish, though still tinted with red. In the pupa, which is readily distinguished by the little wing-pads, the ochreous-yellow extends still more, and finally, with the last moult, the black disappears entirely in the perfect insect. Throughout the miniature stages the shoulders are rounded, not pointed, and the antennæ have but four joints instead of five, as in the mature bug, while there are but two visible joints to the feet, or tarsi, instead of three. . . . The Spined Soldier-Bug by no means confines himself to the Potato-Beetle larvæ, but attacks a great number of other insects."

It appears to me probable that another species which Professor Riley has described as the 'Bordered Soldier-Bug,' also very destructive to the larvæ of the Colorado beetle, is probably identical with the species of *Podisus*, which has been already described in these pages.

Part V. Plate XVII.

Travelling beyond the borders of the class Insecta, we find some occasional destroyers of Aphides among the voracious division of the Arachnida or Spiders, the distinguishing mark of which is the absence of the definite division into three sections: head, thorax, and abdomen, which characterises the former class.

The voracious and carnivorous habits of the group are well known, some species not only devouring other insects, but also those of their own kind, and Col. L. Blathwayt states that in some varieties the females promptly thus dispose of the more diminutive males when their services are no longer required for the propagation of the species. This (to us) unnatural instinct accords well with the popular belief in the ferocity of these creatures, and the danger consequent on the attack and bite of certain of the larger

species, and although the researches of naturalists have gone far to clear away the exaggerated conceptions which formerly prevailed as to the destructive properties of the Arachnida, there can be no doubt that to the largest insects, and possibly to some of the smaller mammalia, the bite of some species may prove fatal, while the *annoyance* which some of the most minute species is able to inflict upon men, is exemplified in the irritation following the bite of the 'Harvest Bug,' one of the family *Trombidiidæ*, or 'Spinning Mites,' to which the aphis-sucking species also belongs.

This family, which belongs to the order *Acarina*, differs from the typical Arachnid in wanting the division into head and abdomen, which is so marked a feature of the latter. In the *Trombidium* the parts answering to the head, thorax, and abdomen are united to form an irregularly-shaped oblong or ovoid mass, covered in the mature state with dense, short hairs or bristles of even length, and sometimes knobbed at the terminations, as in *holosericeum*, or pinnate, as in some other species.

The family comprises a considerable number of species and is very widely distributed, and so nearly do many of the species resemble the species of the nearly related *Hydrachnidæ*, that figures of these may be readily mistaken for those of *Trombidiidæ*. The *Trombidium* in its earlier stage (= larva), is an active six-legged mite, more or less hirsute, but generally only to the extent of stiff bristles, rather sparsely scattered over the body and legs. The mature Trombidium is possessed of eight limbs, and has generally lost the ovoid form which characterises many species in the earlier stage. Four eyes are observable on the anterior surface of the body in *Holosericeum*, and in other species they may with some difficulty be made out, but not often very readily.

The cheliceræ are armed with two minute, needle-like appendages, or with a pair of delicate claws, usually much thinner than the claws of the legs, and they bear also at the extremity a knob-like bristle, or a brush-like appendage, the precise purpose of which it is difficult to recognise. The cheliceræ of the most nearly allied families of the *Acarina* are provided with opposing claws or nippers, recalling those of the crab.

The palpi are terminated by a horny point and a thumb-like process, which is attached below the point by a delicate hinge,

and appears capable of being opposed to the latter. In *Holosericeum* this process is so clothed with stiff bristles as to assume somewhat of a hard character, while in other species a rounded, fleshy structure obtains.

Some varieties are known to be vegetable feeders, and are believed to do considerable damage to plants and trees, to the under surface of the leaves of which they usually attach themselves and suck the sap much as do the aphides. But *Tetranychus telarius*, *Trombidium Holosericeum*, and other species prefer either a mixed or a wholly animal diet, and as the vegetation which they frequent is also the habitat of some of the most prolific species of aphides, the juicy insects afford a convenient and, we may presume, a palatable nutriment. For with the opportunity the meal is repeated, and in the presence of plenty the Aphis-eating habit has become established.

These Arachnida during their early stages are frequently parasitic on some more bulky host either of the insecta or of their own class. Thus, *T. Holosericeum* frequently passes its larval period on the body of the slender Harvest Spider, where it attaches itself to the under surface of the abdomen, or thorax, and may be observed as a scarlet spot, which becomes more prominent as the mite grows in size, and where it at length quits its protecting, though possibly not unwilling, host. It finds in the soil a retreat, where a period of rest analogous to the pupal stage of insects is passed. Two or three weeks suffice for the change, and the minute ovoid nymph produces an eight-limbed mite, which be comes in turn the parent of a new generation.

I have observed the young of a very minute species which I have been unable satisfactorily to identify thus parasitic upon the large black aphis of the poppy, and I cannot avoid the conclusion that, in this case (and probably in the former one), the larva draws its nutriment from the host to which it is attached. It is stated that some species undergo their transformation without quitting their host, but I have myself not been able to confirm this.

The identification of the different species of these curious creatures presents some difficulties, but I have been able to satisfy myself that *Tetranychus telarius*, Linn., *Trombidium Holosericeum*, *Tetranychus tiliarum*, Müller, and a robust specimen covered with

pennate hairs, not identified, are actually aphis destroyers; while I have no doubt that several other closely-related species, which I have been unable to determine, probably have the same habit. But it should be observed that the total destruction of aphides thus effected is comparatively small, and that in all probability the injury inflicted on vegetation far outweighs the service render. ed to man by these minute creatures.

The habit of these mites is to spin a slight fine web on the under surface of the leaves of the vegetation which they haunt, and under this protection the plant-feeders draw their nourishment from the host, while the carnivorous mites go out to find food, and both dispose, between the filaments of the web, the eggs which are to continue the species. These eggs are shown on Plate XVII., Fig. 8. The most striking feature of the mature mites is the curious capitate, or plumose, bristles with which they are closely covered. So densely are they placed, that in *T. holosericeum* a fine velvety appearance is produced, resembling a close, short fur. The plumose bristles which cover some of the most determined aphis-eaters, seem to consist of several short, tapering joints, from each of which some fine hairs diverge obliquely. The character of the slender double claws and the capitate hairs, and brush-like pads, which are their general appurtenances throughout the family, are of great interest; and the small, brilliant, circular eyes may be observed among the bristles along the front of the mite and im mediately above the opening of the mouth. The cheliceræ do not terminate in nippers, and the colour, which is usually of a more or less brilliant red, is sometimes spotted with dark brown.

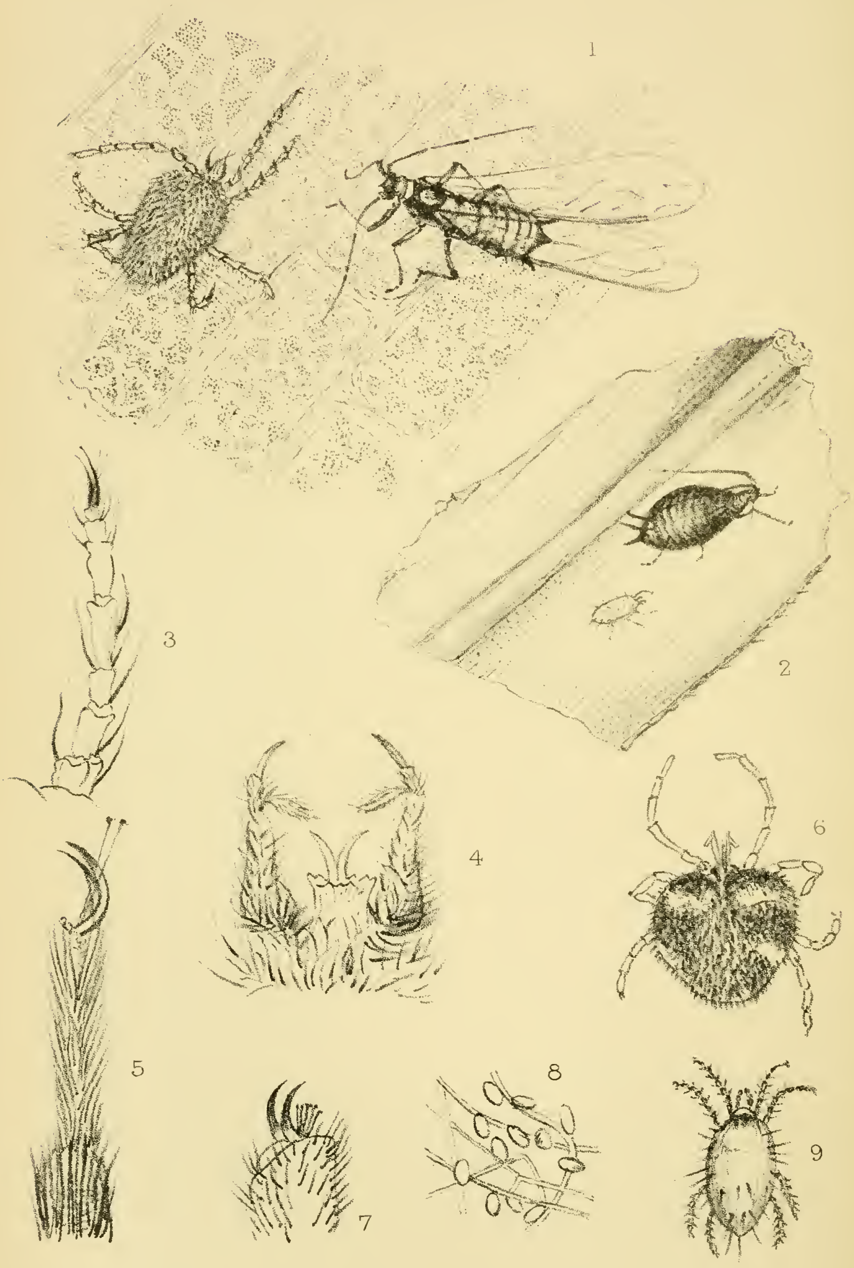
The position of the Family *Trombidiidæ*, in the Class ARACHNIDA, may be seen by the following tabulation :—

CLASS ARACHNIDA.

Orders.—*Arthrogastra*, *Arancida*, *Acarina*, *Tardigrada*, *Linguatulina*, *Pantopoda*.

The *Acarina* are divided into seven families, distinguished as follows :—

I.—Forepart of head prolonged into a distinct beak and separated by a constriction from the rest of the body ... ... *Bdellidæ*



H.C.A. Vine, ad nat. del.

Aphidivorous Acarinae.

II.—Fore part of head not prolonged into a distinct beak.

A.—Skin firm.

1. Skin scarcely extensible, palpi not seated on a common chin piece.
   (*a*) Cheliceræ, claw or needle like; Palpi terminated by pair nippers ... *Trombidiidæ*
   Palpi, with bristles or hook at end ... *Hydrachnidæ*
   (*b*) Cheliceræ, with nippers; first joint of Palpi very large ... ... *Oribatidæ*
   Joints of Palpi nearly equal ... *Cramasidæ*
2. Skin leathery, very extensible; Palpi attached to a chin plate ... ... *Ixodidæ*

B.—Skin soft, with few chitinous bands ... ... *Acaridæ*

EXPLANATION OF PLATE XVII.

Fig. 1.—Acarus (species ?) attacking Aphis on apple leaf (from a mounted specimen shewing both in natural positions).

,, 2.—Larva of a Trombidium, with Poppy Aphis on leaf. This larva was apparently parasitic of the aphis.

,, 3.—Leg of larva in last figure.

,, 4.—Palpi and mouth parts of *Trombidium holosericeum.*

,, 5.—Leg and claw of last.

,, 6.—Acarus (species ?), taken by Mr. Watkins, attacking Aphides.

,, 7.—Claw of last.

,, 8.—Eggs and web (after Miss Omerod).

,, 9.—*Tetranychus telarius*, Linn. (after Miss Omerod).

According to *Meehan's Monthly*, the large majority of plants are scentless, and probably not one-tenth of the hundred thousand flowering plants known to botanists are odorous. Of the fifty known species of the mignonette family, only the one so highly prized in our gardens is fragrant, and only about a dozen of the one hundred species of violet are scented. In many large genera the scentless varieties are as one hundred to one, and sweet-smelling varieties are comparatively rare among our wild flowers.

Half-Hours at the Microscope with the late Mr. Tuffen West.

Plates XXII., XXIII., XXIV.

Arborescent Crystallised Silver (Plate XXII., Fig. 1).—This is truly a lovely slide; when viewed as an opaque object with the light well directed, it is strikingly beautiful, and will tempt many of us to try, by repeating the mounter's experiment, to get its counterpart for our own collection. I have never seen any so perfect of its kind as this is. Its wonderful resemblance in miniature to vegetable growth is well seen by comparing it with the algæ, *Anguinaria dilatata*, happily present in the same box as if for the purpose of comparison. The juxtaposition of the pair suggests thoughts like these :—In each case we have a substance in solution, to begin with—the one a mineral salt, the other vegetable protoplasm. The essential correspondence in the angle assumed by the branches with regard to the main stems indicates that the deposits *must* have been laid in obedience to the same fundamental view, magnetic currents being doubtless the immediate agents, copper having a stronger affinity for some nitric acid wedded to silver, robs the latter and sets free the Dian metal. In the second case, by the play of affinities less easy to comprehend in their entirety, a corresponding force separates what we see here, and lays it down as vegetable growth, on a well-recognised plan, which bears its appropriate name : the "formed material," in one, Pure Silver ; in the other, an "alga." The idea might be extended so as to embrace the Animal Kingdom, in which some of the Sertularian Zoophytes probably show the nearest approach to deposition on the like plan.

Spines of Spatangus (Pl. XXII., Figs. 2, 3, 4, 5, 6).—"Spatangus" is one of the "Heart Urchins." By careful consideration of this specimen, and comparing it with an entire example, we learn that the piece of shell with its attached spines, here shown, has been taken from the right side near the position of the vent. Study of the figures on the Plate, with their explanation, will, I

think, render it unnecessary to say much more about it in these notes.

There are few microscopic objects more instructive or beautiful than these, especially when bleached. An amount of variety will be found in the form, size, and direction of the spines on one of these shells, which will afford much room for thoughtful reflection. The function of those before us appears to be primarily that of defence; on either side of the median line, proceeding backwards from the mouth, is a set, the components of which resemble tiny ivory spoons. I expect these are to aid the creature in burrowing into the sandy tracts in which it resides. Interspersed among the latter are some straight and very slender ones, whose function I take to be probably that of tactile organs, analogous to the "Vibrissæ" of higher animals. The spine-like scales of some insects have a considerable general resemblance to the spines of Spatangus; this is well shown in the wing of the larger Midge.

I do not know if there be sufficient difference in the spines of Spatangi to enable us to discriminate species thereby. The one I am most familiar with, and the commonest, is *S. purpureus*.

Anguinaria dilatata (Pl. XXII., Figs. 7, 8, 9).—There are two well-marked species in this genus which are confounded together by Dr. Johnston (*Brit. Zooph.*, I., 290, and Pl. L., Figs. 7 and 8). These species are *A. anguina*, the common form, and the present one, which is sometimes called *A. spatulata*. Prof. Busk has, with his usual minute accuracy, described the anatomy of *A. anguina* in an old volume of *Trans. of the Microscopical Society of London*. The resemblance in this species to a snake is very striking; the tentacles, when partially protruded, simulating a many-forked tongue. At the aperture of the mouth is a horny lower jaw, horse-shoe shaped in its figure. Mr. Busk described and figured the muscles which open and close this jaw; they are attached to its angle, and consist of a small abductor of two fibres, and a larger adductor, fan-like in shape, on either side of the mouth. The fibres composing these muscles are of the striped kind, indicating the possession of *will* in the creature having them. The long muscle, whereby the polype is withdrawn into its cell, is peculiar, in that the fibres composing it are permanently separate;

that is, they are not united together to form a mass.

A nervous system has been described in some of these Polyzoa. I am not aware that the observations have yet been confirmed; still, the rapidity and consentaneity of their actions seem to render its presence almost (as we might say) a matter of certainty. The polypidom is described by Mr. Busk as subject to a curious accident: the falling off, namely, of the upper part – a fresh portion, or "head," being, however, formed. A "callus," or thickened scar, marks the place of union and reproduction. The specimen before us appears distinctly to show marks of similar fracture and repair.

Eggs of Parasite of Common Fowl (Pl. XXIII., Figs. 1, 2, 3).—It is rather misleading to call this as above, as it appears to imply that there is only one parasite of that bird. There are, however, no less than four species of lice, belonging to as many genera, to which domestic fowls act the part of hosts. These are:—

1, *Goniodes dissimilis.* 3, *Lipeurus variabilis.*
2. *Goniocotes hologaster.* 4, *Menopon pallidum.*

Now, can we find out to which these belong?

Eggs, believed to be from *Menopon pallidum*, the commonest of the four, may be briefly characterised as "upwards of three times as long as broad, scarcely visibly punctate."

Such of the *Lipeuris* as I know are still longer in proportion to their width and smooth. That leaves the maternity of these productions to be settled between the two *G.'s* in the above list: the *Goniodes* and the *Goniocotes.* Does either genus possess species habiting, the one the pigeon, the other the fowl? Such is the case with *Goniocotes!* I think the probability is that these are the eggs of *Goniocotcs hologaster.*

Such furnishes a good illustration of the slow and patient process by which that accurate knowledge of things to which the term "Science" is applied has to be gained, and may serve as some justification of the annoyance felt by scientific men when, from the want of care, or (in some cases) a direct intention to mislead, barriers are erected to their progress, which at times prove very difficult to clear away. It is deeply to be regretted that H. Denny did not live to publish his intended work on the *Eggs*

of the Anoplura, for which he had collected the material. These are now, I believe, at the British Museum, and may be studied by those who will take the needful steps to procure access to them.

Fly (Pl. XXIII., Fig. 4).—The form of the antennæ; the venation of the wings, in so far as can be made out; the general aspect of the legs and their appendages (hooks, flaps, etc.), all proclaim this to be a species of *Scatophaga*. It furnishes a good opportunity for saying a few words on the parts composing the body of an insect. There are, then (with comparatively few exceptions), thirteen segments in all insects. These may be thus enumerated :—

1.—Head (composed of 5 sub-segments).

2, 3, 4.—Thorax.

5—13.—Abdomen; the first six segments containing the organs specially devoted to the reception and digestion of food; the remainder modified in various ways in connection with the genital organs. Two segments only of the thorax have spiracles, the first and the last. The former of these is what is sold by object-vendors for "Spiracle of Fly," and is the one commonly figured. It is curious to find that the male fly has one pair of spiracles more than the female, indicating greater development of the respiratory function for flight in search of her. A correlated fact is that the compound eyes with him occupy a much greater extent of surface, in some instances all but covering the crown of the head. The peculiar hooks terminating the abdomen of the male *Scatophaga* are here well shown.

The males of some flies feed upon pollen and nectar, whilst their partners prefer gross decaying substances.

Hairs of Tiger-Moth Caterpillar (Pl. XXIII., Fig. 5).—The introduction of this specimen to our boxes must be regarded as an important fact, for the necessity of making ourselves thoroughly acquainted with the structure of the common objects around us comes to my mind with continually increasing force.

The caterpillars of the *Bombycidæ* (to one of which those before us belong), many of them possess hairs capable of producing urtication to a greater or less degree. It is not yet quite settled to what this is due. Those, however, who are in the habit

of handling Cacti, and know how their spines get into the skin and rankle there, will not, I think, find it difficult to refer the urtication of caterpillars' hairs to the same merely mechanical cause. A paper on this subject was published in the *Monthly Journ. Micro. Soc.* for October, 1874; but it leaves much to be desired, both in the description and the figures. Some foreign caterpillars sting much worse than any we have—notably *Bombyx processionea*, on which, with much of an entertaining description, consult Kucheumeister's *Manual of Parasites*, Sydenham Soc. Trans.

Scales from Wing of Clothes-Moth, Tinea vestianella, Pl. XXIII., Fig. 6).—It is satisfactory to see this slide for reasons similar to those assigned in the last case. The long hair-like scales fringe the hinder margins of the wings. I believe very little has up to the present time been done towards classifying scales according to their form; referring these forms to their proper places on the wings, etc., and explaining their uses. Here is a wide field open for many workers. The older observers contented themselves with figuring as many varieties as possible—an endless task where, amongst tens of thousands, no two occur exactly alike. There are those who have attempted their systematic study; some have given it up in despair, failing to find any clue through the labyrinth of forms; others have abandoned it from lack of time, or the funds necessary to its successful pursuit. And yet I think there is a clue, and one which is less difficult to find than is commonly supposed. If the feathers of a bird were plucked, a handful of them taken and thrown down indiscriminately, the keenest observer would be unable to refer each to its proper place; and again, "No two would be found exactly alike." But by studying the feathers carefully and minutely on the skin, a reasonable approach to accuracy may be gained; their forms and their uses defined. Bear this in mind as the leading idea required for successful study of Lepidopterous scales, and I am persuaded results far surpassing any yet recorded will be gained. As the result of many careful observations, I am of the belief that (in most of the Lepidoptera at any rate) peculiar scales are present, whereby the species yielding them may be characterised. In the *Pieridæ* and some other genera of Butterflies, the males alone

have remarkable scales not found in the other sex. Those from Garden-Whites and Meadow-Browns are commonly known and figured. John Watson, of Manchester, has done most hitherto towards advancing our knowledge on this subject. His observations, so far as published, are to be found in *Transactions of the Literary and Philosophical Society of Manchester.*

Beetle from Butterfly Cabinet (Pl. XXIV., Figs. 1—7.)—This is *Dermestes lardarius*, the Bacon beetle, the type of the *Dermestidæ.* I have preferred representing her ladyship from a living specimen. You will thereby be better able to recognise her if she come under your notice. The head, thorax, and hinder half of the elytra are pitchy black; over the upper part of her body (and not only when she goes to court, but in every-day life also) she wears a beautiful fur cloak, elegantly "Vandyked" below, with three spots of a rich purple colour on each shoulder. Her offspring is very destructive to furs, stuffed specimens, the contents of entomological cabinets, etc. As to how her ladyship got to where she was found, she might say with Topsy, "I guess I growed there"! The form of the ovipositor leaves little difficulty in settling that point. Her mamma (guided by an acute sense of smell) doubtless inserted her tool as far as she could at some part where the two halves of the box join, then dropped an egg. The little rascal hatched from it, lively and slippery as an eel (having long, polished, backward-pointing hairs all over), soon wriggled its way in, then revelled for a twelvemonth at least on the choice treasures in our friend's cabinet. It then, after moulting several times, at each operation growing much bigger, in due course of nature went to sleep for a time in its last larval skin, through which the perfect beetle burst on arriving at maturity. Westwood has some most interesting notes on this genus (*Mod. Class. of Insects*, I., 155—161), to which reference must be made for further information.

Skin of Carder Fish (Pl. XXIV., Figs. 8—12).—I have spent some time in trying to ascertain the scientific name of this fish, but without success. The scales differ somewhat in form from those of the Lesser Spotted Dog-Fish, *Scyllium caniculum;* still more in the closeness with which they are set on the skin. Still,

the differences do not seem to me greater than may be explained by supposing the pieces of skin to have come from different parts of fish of the same kind. It is of essential importance, in feeling our way to exact knowledge, that every step should be made sure. I wish very much to see longitudinal and transverse sections of these scales, with the skin in which they are implanted, as well as thin sections made parallel with the plane of the tooth-like portion. This will bring out some very interesting points and show how marvellously like teeth they are, both in conformation and in structure. The fish drawn on this Plate (with the hope of ascertaining if it be of the same species with that from which the scales were taken) was a great favourite with me when on a visit to the Boulogne Aquarium. It lay on a ledge of rock, absolutely without motion, all the time its portrait was being taken, and was a very handsome fellow, but with "*such a wicked eye*," like you see in the portraits of Napoleon Trois. What looks like a projecting tusk is but a fold of skin which hangs down on either side of the mouth—a sort of feeler, in fact. These fish were not uncommon in the Boulogne market; some reached a length of three feet and upwards. I was informed by the keeper of the aquarium that their French name was "Roussette."

Transverse Section of Human Molar (Pl. XXIV., Fig. 13) is described in the explanation to the plate. Will some member illustrate for us the structure of human teeth in their various forms by vertical and horizontal sections? Then follow it up by sections of pachydermatous teeth—rodent, carnivorous, lacertine, piscine, etc. They would form an endless series of beautiful and instructive objects, especially if fossil teeth were included, and would be most interesting. TUFFEN WEST.

There has been established in Berlin a People's Society for Natural Science, the chief object of which is to offer scientific lectures that will be interesting to those having no technical knowledge of the subject. The first lecture before the Society was given by Dr. Förster, Director of the Royal Observatory, and entitled "Conditions and Beginnings of Life on the Earth."—*Science.*

Selected Notes from the Society's Note-Books.

Spatangus.—I find in Maunders' *Treasury of Nat. History* that this species of *Echinodermata* is almost always found buried in the sand. They feed on minute animals abounding therein, their alimentary canal being filled with sand containing them. As their power of locomotion and prehension is very small, it is difficult to imagine how such an animal can obtain sufficient nutriment for its subsistence. E. LOVETT.

Dermestes lardarius.—I can attest as to the nuisance these fellows are to a cabinet, and find a good plan to adopt is to examine the drawers *carefully* occasionally, and remove any specimens under which a little dust is to be seen, as, whenever any of this dust appears under a beetle or moth, it is certain an intruder is commencing operations.

Several of these beetles, together with some of their larvæ, were found *dead* in some Egyptian mummies in the inside of the bodies, and it was thought they got there before the final embalming took place. E. LOVETT.

Hairs of Larva of Lepidoptera form interesting objects, those of *Arctia caja* (the one under consideration) being the general type ; the cocoons of moths being the best to illustrate them, as the larva intermingles its hair with the silk of the cocoon, and the two may be seen well together. The tuft hair from the larva of *Orygia antiqua* are very curious indeed, and it has just occurred to me that, just as the nails and horns of animals represent hairs solidly bound together, so probably the spines at the tail of the larva of the *Sphingidæ* may (if cut into longitudinal* sections) exhibit all or a part of the characteristics of consolidated hairs. The spines of the larva of *Vanessa urtica* are curiously formed, and represent a short, branched hair, though literally a spine ; and the skins of smooth larvæ, of which there are, of course, an immense variety, exhibit, when viewed microscopically, a number of very short, stumpy spines, frequently double, which are the

* Would not transverse sections show this better?—ED.

representations of the bunches of hairs of the so-called hairy larvæ. E. LOVETT.

Caligus Mullerii.—I took several of the *Caligus Mullerii* on codfish here. On a lank and sickly fish of about ten pounds weight, I found as many as five dozen. I observed that only a very few of these parasites were to be found on healthy and well-fed fish; but the one I have referred to as bearing so many had apparently met with an accident, whereby the sight of one eye had been destroyed, and as the injury appeared to be of old standing I judged that deficient nourishment had been consequent on defective vision, and analogy seemed to teach that such deficient nourishment had favoured the increase in the number of these parasites.

During some two days I must have examined over two hundred fish; but my observation does not confirm the opinion that the Caligus particularly affects the gills or mouth, for I found but few specimens in this position. It was a congener of this fellow (*Lerneopoda*) which is mentioned by Scoresby as attaching itself to the eye of the shark, and by piercing the tissues destroying the vision of its victim; but the damage to the *Gadus Morrhua*, from which this specimen was taken, appeared rather to have had its origin in other causes. There is, I believe, and I think I have seen (before I knew of its existence), an animal living parasitically upon this entomostracan parasite. W. LANE SEER.

Dog-Fish.—Mr. Tuffen West's very accurate sketch (Pl. XXIV.) is really a portrait from life of what Mr. W. says he "takes to be" the smaller spotted dog-fish. My friend, Mr. Henry Lee, has been most successful in breeding them in the Brighton Aquarium, and has actually induced, and then watched and recorded, the process of egg-laying by the fish, exemplifying by actual observation the uses as well as the application of the long gelatinous tendrils (three to thirty feet) which are attached to the corners of the (mermaid's purse) egg.

I believe that the skin of both the larger and lesser spotted dog-fish is applied commercially in the manufacture of corn-rasps sold by many druggists; indeed, a chemist on the south side of Fleet Street has, or had a short time ago (1875, Ed.), a whole pile of these corn-rasps lying in his window, with a stuffed specimen of

the Scyllium suspended above them, though it occurred to me as I passed by, that not one in a million who throng that busy thoroughfare would be likely to discover the connection intended to be conveyed. W. LANE SEER.

Cherry-Stone, Tr. Sec.—It will be noticed that the grain runs in three different directions : the outer in lines converging towards the centre, the middle in longitudinal lines from end to end, and the inner in a matted mass round the stone. W. M. APPLETON.

Cuticle of Plants, To Prepare.—I have prepared some hundreds of cuticles in past years by the following method :—Place the leaf in a test-tube in a little solution of caustic potash (*liquor potassæ* of druggists), boil for a short time, varying in the case of different leaves from a few seconds to several minutes; turn the contents of the tube into a beaker of hot water and swill round, and then removing the leaf open it out with a broad scalpel under water. If the leaf be snipped round one edge before it is placed in the potash solution, it will open out spontaneously.

The vascular system of the leaves are remarkably well prepared in this way, the minute terminations remaining attached, and in many cases manifesting special characteristics. See on that point Herbert Spencer's *Principles of Biology* and reprint of a paper (in that volume, I think) read by him many years since before the Linnæan Society.* H. POCKLINGTON.

Chrysis ignita.—Nothing can exceed the splendour and brilliancy of the *Chrysididæ.* Latreille compares these insects to precious stones, and supposes that their superb colour dazzles their enemies, and so facilitates their escape. They seem timid, for directly they are touched they roll themselves into a ball. They have a very weak sting, placed at the extremity of their long telescopic-formed oviduct (only able to pierce soft bodies). This flexible tube can be extended to a very great length, and is frequently exserted. It is brownish-ochre in colour, the terminal plate of the abdomen beneath being generally black.

These insects are not uncommonly found on walls and windows in very hot weather, and their brilliantly-coloured thorax and abdomen, as well as their velvety black antennæ, and yellow or blue-

Linn. Soc. Trans., XXV., 405.

green backs thickly and coarsely punctured, clothed with upright, soft, grey hairs, make beautiful objects for the microscope.

E. E. JARRETT.

Ditto.—The *Chrysididæ* are indeed among the most beautiful of our insects. They are parasitic upon the insects, mostly affecting the larvæ of solitary HYMENOPTERA, among which the well-known Sand-fly (*Oolynerus ?*) is a frequent victim. This insect is wonderfully persevering in its attempts to deposit its eggs. The sting like ovipositor is capable of inflicting a smart prick when the insect is moved to anger. J. H. WILSON.

Some Additional Remarks on Finishing Slides.*

I am very much averse to making mounts conspicuous by ringing them, which I think white varnish does without in any way adding to their strength. It seems quite unnecessary to ring a balsam mount, which, if made of fairly colourless balsam, looks very nice, if carefully done, without any cleaning off. It is only balsam which has been unduly heated and dried (before making up with xylol or other solvent), which cracks off, and such mounts are unpleasantly yellow, not to say brown. The balsam I have always used looks quite colourless on the mount.

For mounts in fluids where it is absolutely necessary to put a ring to prevent the fluid escaping, I much prefer plain gold-size, which looks well, is transparent like the mount, and never cracks. I generally go over rings of gold-size three times. J. GIFFORD.

On reading the remarks on finishing slides, I at once asked, "Why ring balsam slides at all ?" To add black, white, or black and white, or coloured rings to such a slide as Fig. 2, is as useless as "to gild refined gold or paint the lily." Nor do I think that in a climate like ours such ringing adds anything to the *security* of a *balsam* mount. The superfluous balsam would serve nearly the same purpose as a ring of a different material, and, unless excessive in quantity or very uneven, is surely no dis-sight. It may be, however, that balsam slides in a *hot climate* require ringing with some substance not so easily affected by heat. A friend of mine returning from the Antipodes found on reaching England

* For earlier notes on this subject, see this Journal for 1894, p. 102, etc.

that the heat on and near the Line had melted his balsam, and had allowed the cover-glasses to fall to the bottom of the racks. Even then, if the slides had lain flat, no harm might have happened.

There is, I think, a practical inconvenience in ringing slides that require to be examined with a high power, and that is, you cannot *slide* your *slide* off the stage without screwing up the microscope, and so losing your focus; at least, this is so with a simple stage like that of the Hartnack microscope. Of course, when one comes to deal with deep cells, either for balsam or glycerine, ringing and finishing become of first-rate importance. How almost invariably the glycerine slides are spoiled, or at least damaged, before they have completed the circuit of the P.M.S. Farrant's medium, ringed with asphalte, stands much better than glycerine. R. S. PATTRICK.

I own to being very much interested in the subject on mounting and ringing slides. For years I have followed the idea given me by an old friend, and use various colours for the different groups of slides, viz. :—Green for vegetables; blue for diatoms; purple for insects; red for animals; and white and black for polariscope objects.

I get a small tube of oil-colours, and squeeze a little into a homœopathic bottle; then I pour a little benzole in and let it soak for a day or two to take up the oil; then I pour away the oily benzole and put in some fresh, and all is ready. Having ringed on the zinc-white cement, I at once apply the colour of the ring, as desired; the benzole takes it over to the zinc-white, and the slide is done. The advantage is that if you are showing slides to people, you know from the colour of the ring the class of subject you are showing, and when you want to put away your slides you perceive at once where they are to go. I admit that there is no further use in ringing slides, but why may not the outside look pretty? A. CLARKE SMITH.

In my opinion, by far the neatest way to finish a balsam slide is to put a ring of balsam on instead of zinc white.

JOHN E. FAWCETT.

If an object is worth the labour of preparing, surely it deserves finishing in a neat manner. For some years I have used zinc white with a red or black band. J. PHILLIPS.

Some Slides from Jersey, contributed by Mr. W. Pumphrey.

My contribution for this year to the Postal Microscopical Society consists of twelve slides prepared at the Biological Laboratory, Jersey, and may, I think, be taken as fair specimens of the style of work of that establishment. They are selected from three of the lower orders—viz., the Sponges; the Actiniæ; and the Echinoderms.

Sponges.—The sponges form almost, if not quite, the lowest of animal tribes. They consist of a gelatinous mass, supported and maintained in position by a skeleton composed of spicules. Sometimes the spicules are siliceous and sometimes calcareous. The simplest form is that of a small mass of gelatinous matter, supported by these spicules, so formed as to imbibe from the outside through minute passages the liquid (whether it be salt water or fresh) in which the organism lives, and from which it derives its nourishment; the liquid being ejected from a central orifice. By a series of buddings the simple cell becomes built up into a large aggregate of individuals.

No. 1 is an entire specimen of a sponge, with calcareous spicules. The specimen consists of a small group of associated individuals, in different stages of growth. The spicules in this species are trifid.

No. 2 is a section of another calcareous sponge; the spicules are more robust; and in making this section the greater part of the spicules have been broken. Those in the interior of the organism are very much larger than those near the exterior, and which by their close aggregation and interlacing give firmness to the exterior part.

No. 3 is a section of a siliceous sponge; here the spiculæ are of two distinct forms. Scattered through the mass are minute spiculæ, having four points, while others of simple acicular form are scattered irregularly about. The specimen also contains large numbers of Sterrasters, or oval spicules, which are closely aggregated towards the exterior of the organism.

Spongilla fluviatilis.—No. 4 is a section of a fresh-water sponge (*S. fluviatilis*). This specimen is literally filled with statoblasts or winter germs; these are seen to be built up with spiculæ of a different make from those of the mass—bi-rotate—with eight or ten points.

The four following slides are from the family of the *Actiniæ*, the Sea Anemones. This group of animals consist, in their simpler forms, of a gelatinous sac, unsupported by spiculæ, with a cavity which acts as a stomach, and of which the orifice is surrounded by a row, or rows, of tentacles. In some species the soft matter of the animal, as in the *Sertulariæ*, is supported by a horny polypidom; in others, as the *Alcyonium*, the soft matter is stiffened by numerous short, calcareous spiculæ; while in others, as the Corals, the polyps secrete a skeleton of calcareous plates, within the limits of which it can withdraw itself when disturbed. Our specimens are confined to the first and third of these groups.

Adamsia rondoletta.—No. 5 is a section of *Adamsia rondoletta*. The *Adamsia* are sea anemones that are almost always found adherent to the vacant shells of certain molluscs; they affix themselves round the orifice of these shells, whence they are called "Cloak anemones," and the shell is very often found to be also tenanted by a hermit crab.

On No. 6 are sections of the anterior and posterior parts of *Peachia hastata*, an anemone which buries itself in the sand, having the power, at will, of protruding the anterior part through the sand and displaying its row of tentacles.

Alcyonium digitatum.—No. 7 comprises sections of *Alcyonium digitatum* (Dead Men's Fingers), one of the composite *Actiniæ* that secretes calcareous spicules, which in the specimen are seen *in situ*. It will be noticed that they are closely aggregated towards the exterior of the animal, giving it solidity and firmness. The section also shows the polyps occupying cells near the exterior of the composite animal.

No. 8 is one of the polyps of *Alcyonium digitatum* detached from the mass, in order to show its analogy with a simple actinia.

The remainder of the slides are preparations from the class of animals of which the ordinary Star-fish (Cross-fish) is the type.

No. 9 is a transverse section of one of the arms of the common star-fish, *Uraster rubens*, and No. 10 a longitudinal section of the same, displaying very clearly some of the wonderful arrangements of the star-fish group.

No. 11, a ventral section through *Asterina gibbosa*, one of the smaller species of the star-fish family.

No. 12, anchors and plates of *Synapta digitata in situ.* The Synapta, or Sea Cucumber, belongs to the Echinoderms, but is a transition form, connecting them with a more highly organised group. Instead of having a stiff, shelly covering, through which the organs of locomotion and prehension protrude, the Sea Cucumbers have an integument of a leathery consistency, and embedded in the integument are to be found the various spines and plates so well known in collections of microscopical preparations. In this section they are seen *in situ* in a portion of the integument.

WILLIAM PUMPHREY.

Alcyonium digitatum.—Slide No. 8 is a very beautiful slide of a polyp of *Alcyonium digitatum* ("Dead Men's Fingers." "Cows' paps," "Mermaids' Fingers," etc.). *A. digitatum* is typical of the order *Alcyonaria.* It is met with as deep as seventy fathoms, but is common in much shallower seas. It is widely distributed, and is about equally abundant in tropical and temperate waters. The *Alcyonaria* date back to the cretaceous period; when dredged up it is repulsive in aspect, and has thus earned its not very attractive common names; but placed in sea water, its sponge-like mass distends, becomes pellucid, and from all parts of its surface numbers of exquisite polypes, of which the mounted specimen is one, expand their star-shaped crown of tentacles, and the previously uninviting mass becomes an object of extreme beauty.

The tentacles are fringed, and within, circulating currents may be observed finding their way up one side and down the other, following the course of several fringes; by the action of their ciliated walls they seem to fulfil the function of a respiratory system.

The skeleton is sclero-basic and spicular, and is well shown on the slide with a ¼-in. objective.

The slides of Sponges and Spongillæ are most interesting. Going through a series of locally collected sponges with a friend at Ramsgate a few weeks ago, we could neither of us determine whether the axis of the bi-rotate spiculæ are hollow or no (slide No. 4), a bright spot in the centre of the radiating points seeming almost to indicate this. Perhaps members working with higher powers can determine (my highest power is ¼-in. with B eyepiece).

J. LUCAS.

Observing the transverse section of the Burrowing Anemone with a 1-inch objective, observe the three body layers—ectoderm, mesoderm (stained crimson in the section), and endoderm. The ectoderm contains the stinging cells, or nematocysts, with which the anemone paralyses and kills its prey. The mesoglæa is composed of muscular tissue; the endoderm lines the entire body-cavity in all its chambers with a coating of ciliated cells. Note the œsophagus (the round circle in the middle). In this specimen the section has been slightly crushed by pressure of the cover-glass.

Notice also the short, pouch-like outgrowth from the œsophagus; this is the siphonoglyph. Most anemones have two of these, but *Peachia* has only one. These siphonoglyphs are angles which bound the extremities of the mouth-slit; they are continued downward into the œsophagus as deep, richly ciliated grooves, and remain open even when the animal is greatly contracted. They appear to be useful in keeping up a constant flow of water through the œsophagus.

Note also the twelve mesenteries which serve to break up the great body-cavity into a number of radial longitudinal chambers. These mesenteries are arranged in pairs; some reach across to the œsophagus, and are called *primary* mesenteries; others fall short of it, and are called *secondary* mesenteries.

Observe the ridges on one face of the mesenteries, and notice in the section muscle fibres forming a beautiful arborescent pattern. These are the muscles which pull down the tentacles and mouth disc, so as to shorten and retract the animal. The accompanying rough illustration may serve to explain these remarks.

Unsigned.

EXPLANATION OF PLATES XXII., XXIII., XXIV.

Plate XXII.

Fig. 1.—Arborescent Crystallised Silver.

,, 2.—Represents a portion of the specimen shown with spines partially seen, in different positions, × 25.

3.—Figure of *Spatangus purpureus* from above, to show the form of the shell ; *m.* indicates the position of the mouth, which is on the under surface ; *p.v.*, position of the vent.

,, 4.—Base of a large spine, to show the cotyloid cavity, the strong ridge for attachment of muscles which move it, and the rectangular form of the meshes in its calcareous network.

,, 4*a*.—Sectional view of the spine, taken at about two-thirds of the length. × 20.

,, 5.—Truncated column on which the spine is placed, having at its top a smooth, rounded eminence, with depression for attachment of a round ligament. × 20.

,, 6.—Diagram of the parts, in sectional view :—*Sp.*, Spine ; *rd.*, *rd.*, Ridge near its base for muscular attachment ; *r.l.*, Round ligament ; *ab. m.*, Abductor muscle, which, acting at a disadvantage, has its attachment both above and below to a projecting ridge ; *ad. m.*, Adductor muscle.

,, 7.—Portion of Seaweed, with *Anguinaria dilatata* attached.

,, 8.—*Anguinaria anguina*, with polyp partially protruded.

,, 9.—Head of same, more enlarged, and horse-shoe-shaped chitinous lower jaw.

,, 10.—Another specimen, showing repaired fracture of the neck. *ad. m.*, Adductor muscle of jaw ; *ab. m.*, Abductor muscle of neck ; *r.f.*, *r.f.*, Place of repaired fracture. Near the top, towards the right hand side, are some Diatoms, probably *Rhabdomina minuta.*

Plate XXIII.

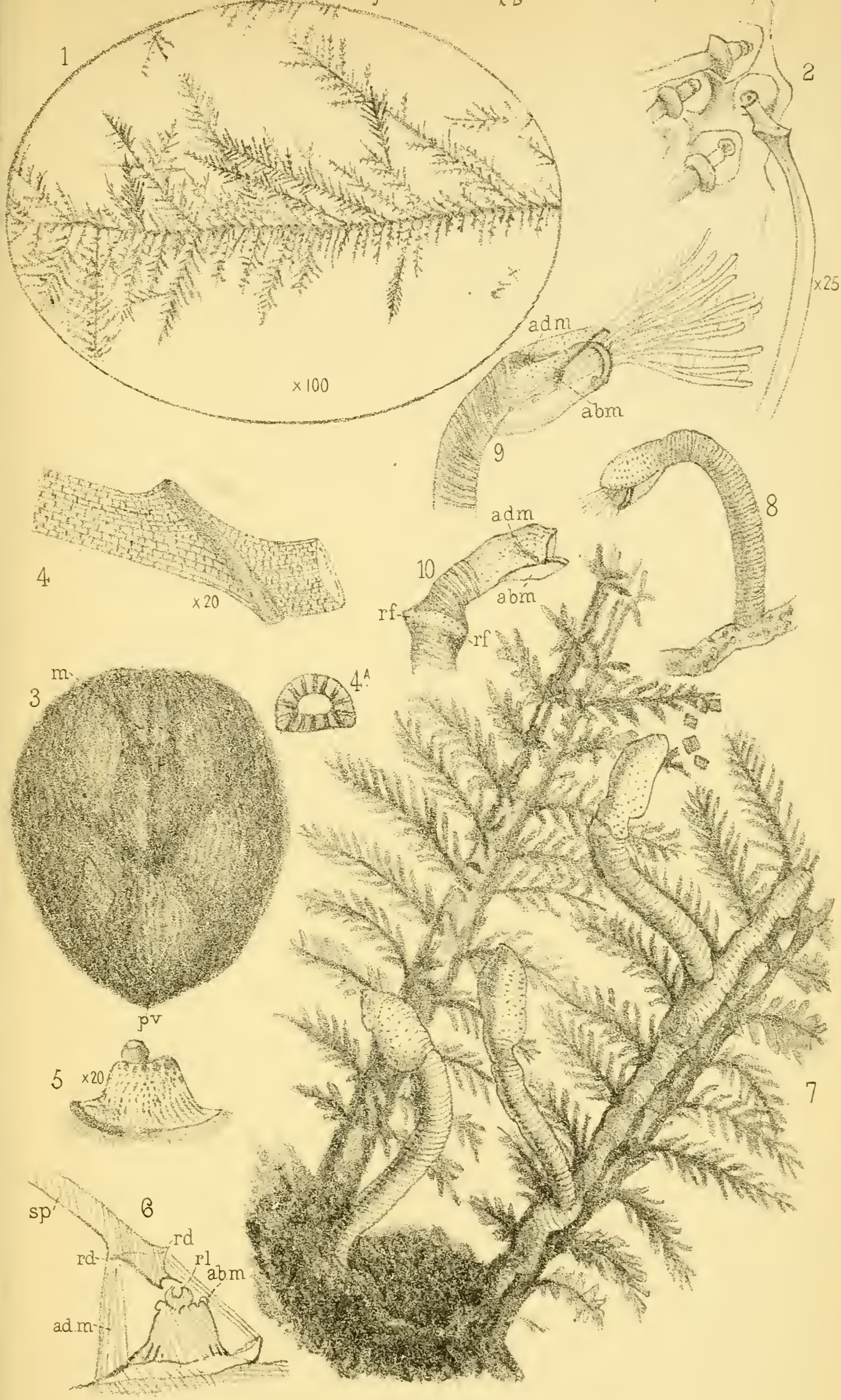
Eggs of Parasite of Common Fowl.

Fig. 1.—One of the Eggs, showing the triple coronet of horny cilia surrounding the mouth ; the hexagonal areolation, seldom so strongly expressed as in the figure, the lid, and the glutinous material at the place of attachment.

,, 2 and 3.—Further illustrate some of these points.

,, 4.—Illustrating some points in a species of Scatophaga, ♂. The figure represents the thorax and abdomen, and is specially designed to show the number and position of the segments composing them, and of the spiracles.

h., Position of the head ; *tx.*, Thorax, composed of *p.t.x.*, Prothorax ; *m.s.x.*, Mesothorax ; *m.t.x.*, Metathorax. The abdominal segments are denoted by the letters *a.s.*, with 1, 2, 3, etc., for first, second, and third abdominal segment, and so on ; *p.t.x.s.*, Prothoracic spiracle ; *m.t.x.s.*, Metathoracic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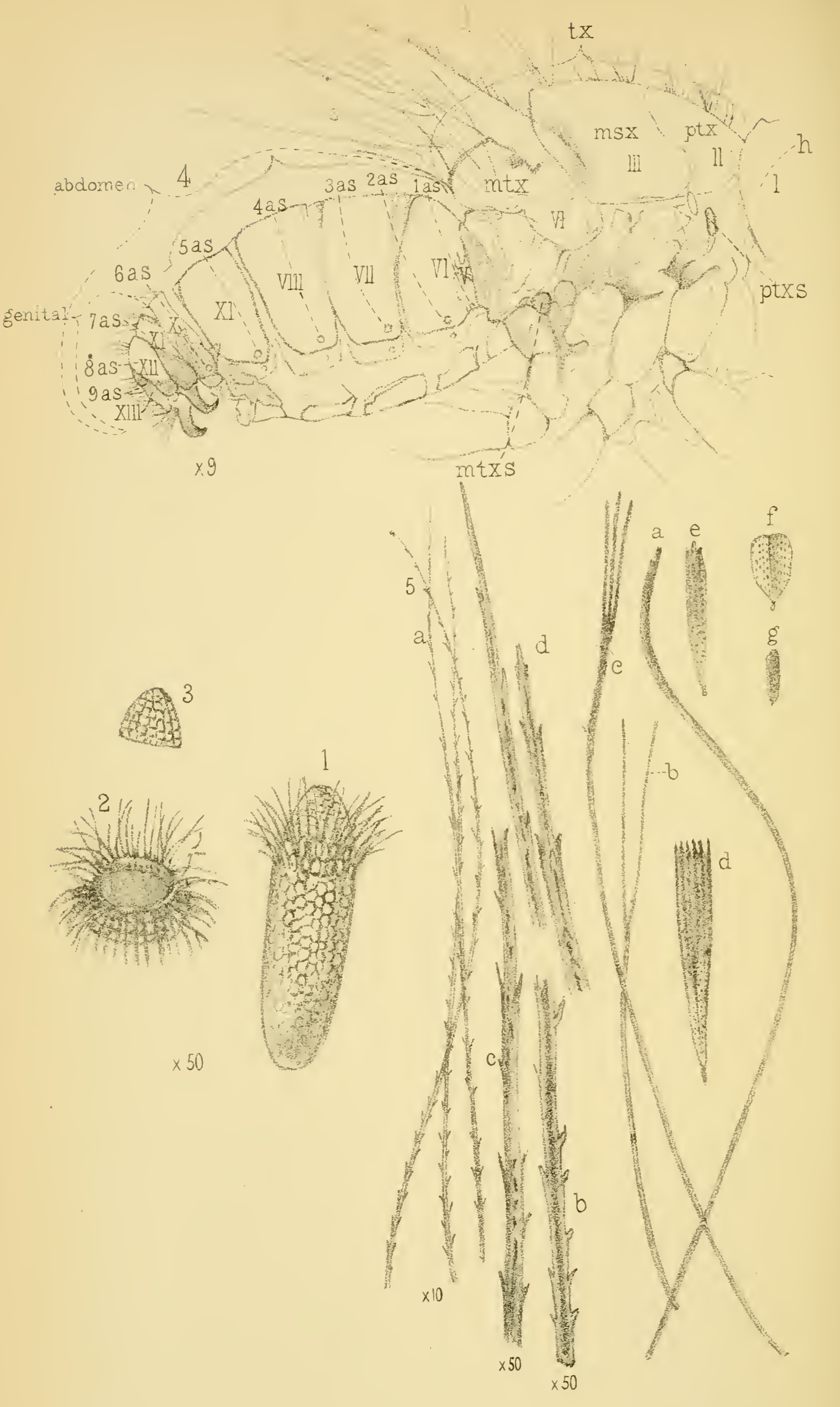
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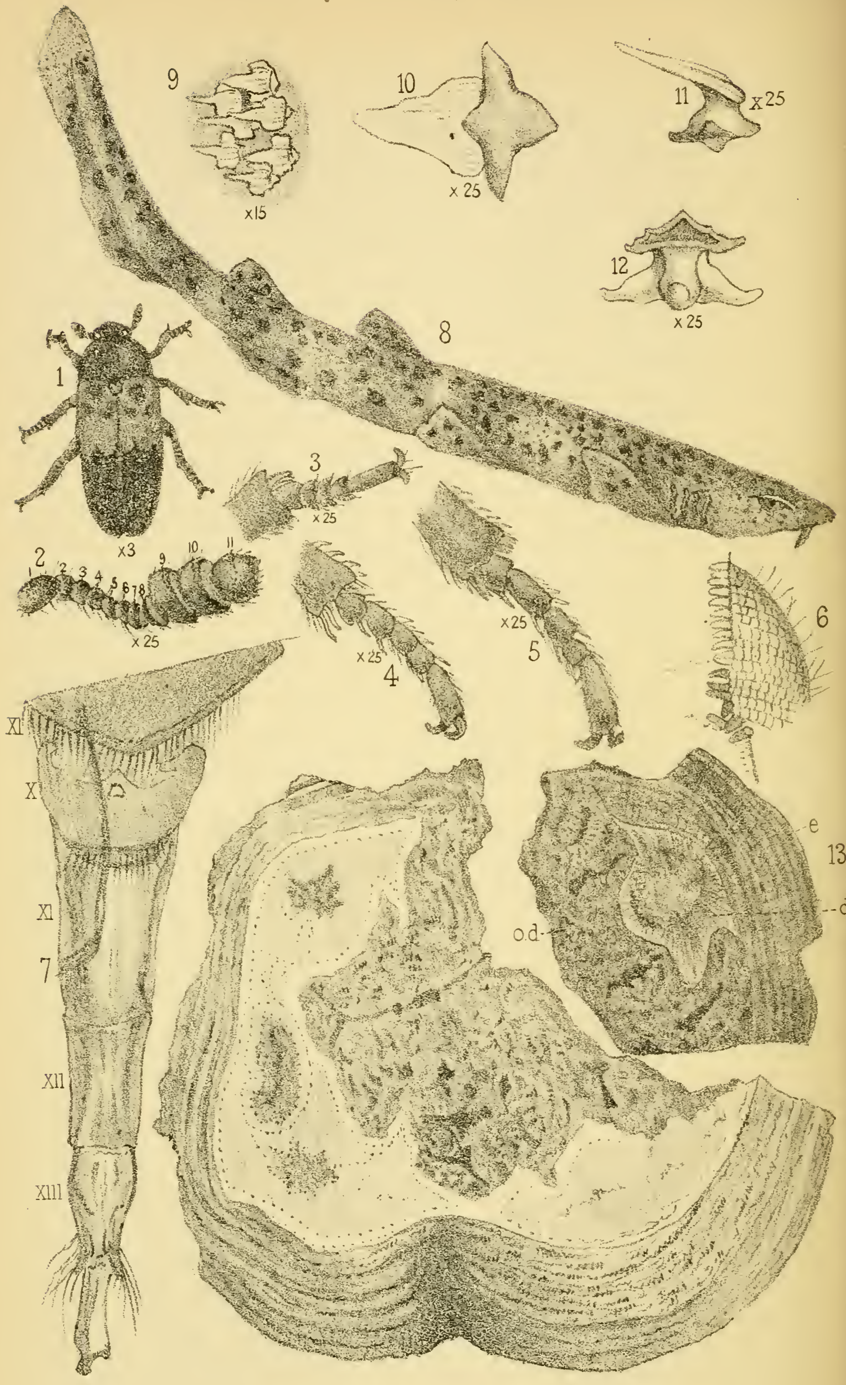
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spiracle. The Roman numerals are placed in their respective segments.

Fig. 5.—Hairs from Caterpillar of Tiger Moth.
a, Three hairs slightly magnified, × 10.
b, Base of a brown hair, × 50.
c, Central portion of one of the grey hairs, × 50.
d, Apex of a brown and of a grey hair, × 50.

,, 6.—Scales from wing of *Tinea vestianella.*
a, Long, slender, hair-like scale.
b, Bifurcate ditto.
c, One of the same class, with three forks.
d, Large characteristic scale from central portion of wing.
e, Smaller scale belonging to the same class.
f, Small translucent scale, having perhaps sensory functions.
g, Very minute scale, perhaps ill-developed.
Note.—These scales should have been separated from the Hairs on the Plate by a vertical line. We observe also the numeral 6 is omitted.

Plate XXIV.

Fig. 1.—*Dermestes lardarius*, Bacon Beetle, from living specimen, × 3.

,, 2.—Left Antenna, showing the number of articulations, × 25.

,, 3.—Fore tarsus from left side. } × 25.
,, 4.—Middle tarsus do. } × 25.
,, 5.—Hinder tarsus do. } × 25.

,, 6.—Portion of compound eye of the left side, showing the pyramidal sclerotics of several of its facets.

,, 7.—Ovipositor. The Roman numerals denote the segments represented by the joints composing it.

,, 8.—Reduced figure of a drawing made from the life, in the aquarium at Boulogne-sur-Mer, of what I take to be the small spotted Dog-Fish.

,, 9.—Portion of the skin, with scales, from specimen on slide, × 15

,, 10.—Scales of *Scyllium caniculum*, with the expanded base uppermost, × 25.

,, 11.—Side view of another scale of the same, × 25.

,, 12.—Sectional view of same, specially given to show the outline of the tooth-like plate of the scales, × 25.
The three latter figures, taken from specimens separated by the action of potash, kindly given me by another member.

,, 13.—Transverse section of Human Molar Tooth, × 3, showing—*e*, Enamel; *d.*, Dentine; *o.d.*, Osteo-dentine, or "cement," which appears to have invaded and completely filled the central pulp-cavity, with devarications therefrom.

All drawn by Tuffen West.

Erratum.—Explanation of Plate XXII., Fig. 2, p. 392, should read "Represents a portion of *Spatangus purpureus*, with," etc.

Microscopical Technique.

Storax as a Mounting Medium.—Permanent preparations can be mounted in storax, according to Dr. J. H. Piffard *(Medical Record*, 1895, p. 547), if it be prepared as follows:—The storax is liquified on a water bath, then filtered through two or three thicknesses of cheese cloth, on a hot-water funnel, and when cold mixed with an equal weight of xylol. Shake well several times daily for at least two weeks, then filter two or three times through absorbent cotton or Swedish filter-paper, and evaporate at a gentle heat to the consistency of treacle. Finally, to each two parts of the fluid add three parts of naphthaline monobromide, and heat gently until a clear amber-coloured fluid is obtained. Preferably, the refractive index of the medium should be brought to 1·625, by adding more of the ingredient that may be found deficient, and the product will then be found suitable for work with the highest powers.—*Pharmaceutical Journal.*

Brown Cement, suitable for microsco ic wor —The *Chemist and Druggist* recommends either a thick solution of shellac in vegetable naptha, or of gutta-percha in chloroform or bisulphide of carbon.

To find Micro. Objects.—It may not be generally known to those who mount their own slides that much good material can be found during the winter by examining the stems of any dried plants in the hedgerows, as, *e.g.*, Nettle, Cock's-foot Grass, etc. In this manner various and often rare insects can be taken in fine condition The most productive stems are those *not* in a vertical position, as when standing at all upright the rain can enter, which makes it too uncomfortable for insects to take up their winter quarters there. It is a good plan, when the day is very cold, to take the stems home in a paper bag, and examine them over a sheet of white paper. Moss collected in the woods will also yield good results, especially in the beetle tribes. C. J. WATKINS.

Nutrient Gelatine.—To prepare this, first make beef broth by mincing 450 gm. of lean beef, free from all fat and connective tissue, and boiling for half-an-hour in a large flask, with a litre of distilled water. Filter and make up to one litre with water, then add sodium chloride 5 gm. and pure peptone 10 gm. Heat the mixture in a flask on a water-bath at 100° C. for an hour, shaking from time to time. Now cautiously add concentrated solution of sodium carbonate until faintly alkaline, and again heat at 100° C. for half-an-hour. Next, allow 100 to 120 gm. of sheet gelatine to soak in the broth for half-an-hour; heat slowly on a water-bath until the gelatine is dissolved; neutralise carefully, and again heat for half-an-hour. Then add the white of an egg, heat till all the albumin is precipitated, and finally filter through two layers of moist filter-paper, on a hot-water funnel, into sterilised flasks, and sterilise on a steam steriliser for twenty minutes on each of two successive days.—*Pharmaceutical Journal.*

Inoculating Culture Tubes.*—Beneke recommends that gelatin culture tubes should be inoculated by making a puncture at the side of the medium close to the glass. The advantage of this method over the older plan of inoculating the mass in the middle is that the growing culture can be microscopically examined from the outside and various details made out, such as the nature of the growth, the comparative appearance of colonies near the surface and those situated more deeply, and the presence of one or more distinct organisms. If the tubes used have the opposite sides flat and parallel, such examinations will be still further facilitated.

A New Method of Preparing Serum Agar-Agar.—Drs. Kanthack and Stephens suggest in the *Lancet* the utilisation of pathological serum, such as ascitic, pleuritic, and hydrocele fluids, of which there is always a large supply at a hospital, for the preparation of serum agar-agar culture medium for the separation of the typical diphtheria bacilli. The following method gives a beautifully clear and transparent medium in less than half-an-hour:—To every 100 c.c. of serous exudation, 2 c.c. of 10 per cent. caustic potash is added; 1·5 to 2 per cent. of agar-agar previously soaked in

* *Cent. f. Bakt.* in *Pharm. Journ.*

acidulated water is next added. The mixture is then boiled in a Koch's steamer until the agar is dissolved, after which it is filtered through a hot-water funnel, and 4 or 5 per cent. of glycerin added to the filtrate. The medium is now ready for sterilising in test-tubes in the ordinary way. Sometimes the serous fluid is very rich in albumin. Before adding the potash, a little should, therefore, be boiled in a test-tube; if it becomes practically solid or contains a large excess of albumin, it should be diluted with at least twice its bulk of distilled water.—*Pharmaceutical Journal.*

The Staining of Cellulose.—Varying results may be obtained on staining cellulose, according to its age, young and soft tissue absorbing stains with least difficulty, whilst maturer tissues may remain unaffected by the same stains. Dr. E. G. Love studied the subject, and made comparative tests with a view to determining the value of different stains. He found that some stains—such as hæmatoxylin—require no mordant to fix them, whereas carmine stains generally require a mordant, such as alum. The mordant may be mixed and applied with the stain, or it may be used subsequently; or, again, the tissue may be impregnated with the mordant before the stain is applied. There are thus four ways of staining tissues. The last-mentioned was found best for preparations which are difficult to stain. In the specimens of cotton and linen fibres treated, the cellulose was, of course, not in such a receptive condition as young and soft cellulose tissue, for in proportion as the cellulose increases in density it affords a greater resistance to the action of stains. Thus, Grenacher's solution of carmine in alum was found to produce a slight reddish tint only after twelve hours; Thiersch's solution in oxalic acid a dull rose colour after eighteen hours; and borax carmine, with oxalic acid as a mordant, was no better than Grenacher's solution. The cotton fibres were stained light blue by hæmatoxylin and alum, but any depth of colour could be obtained by applying a mordant (alum, aluminium, copper sulphate, or acetate) first. Methyl green produces a deep green when the fibre has been previously mordanted, but light green if stained first.—*Pharmaceutical Journal.*

Reviews.

A Text-Book of Histology, Descriptive and Practical, for the Use of Students. By Arthur Clarkson, M.B., C.M.Edin.; with 174 original coloured illustrations. 8vo, pp. xx.—554. (Bristol: John Wright and Co. London: Simpkin, Marshall, and Co. 1896.) Price 21/- net.

It is with much pleasure that we direct the attention of our readers to this really magnificent work, the purpose of whose author has been to furnish the student of Histology with both the descriptive and practical parts of the science. The first two chapters are devoted to the consideration of the general methods of Histology; subsequently, in each chapter, the structure of the tissue or organ is first systematically described; the student is then taken historically over the specimens illustrating it; and, finally, an Appendix affords a short note of the methods of preparation. We give a summary of the more important subject-matter of the various chapters:—Chaps. I. and II., General Methods; Chaps. III.—VII., The Simple Tissues; Chap. VIII., The Vascular and Lymphatic Systems; Chap. IX., The Spleen and Ductless Glands; Chap. X., The Respiratory System; Chaps. XI. and XII., The Alimentary Canal; Chap. XIII., The Kidney, Ureter, and Bladder; Chap. XIV., The Skin, Epidermic Appendages, and Termination of the Sensory Nerves; Chap. XV., The Reproductive System; Chap. XVI., The Eye, Ear, and Olfactory Membrane; and Chap. XVII., The Nervous System. There is also an exhaustive index. The information given throughout the entire work is thoroughly plain and concise. Besides the 174 beautifully coloured plates, there are 22 wood engravings in the text.

Rheumatoid Arthritis: Its Pathology, Morbid Anatomy, and Treatment. By Gilbert A. Bannatyne, M.D.Glas., M.R.C.P.Ed. 8vo, pp. xii.—173. (Bristol: John Wright and Co. London: Simpkin, Marshall, and Co, 1896.) Price 7/6.

Chap. I. of this work is Introductory and Historical; Chap. II. treats of the Ætiology and Pathology of the subject; Chap. III., Pathological Anatomy and Bacteriology. These chapters are followed by others on Diagnosis, Prognosis, and Treatment.

The Ritual of Health for the Grown. By H. Cooper Patten. Cr. 8vo, pp. 125. (London: Jarrold and Son. 1896.) Price 1/-

This, the first of three volumes in course of publication, is intended for the guidance of men between the ages of 30 and 60 and of women five years younger, and contains an amount of good common-sense information, from which all may derive much profit. We regret that the book came to hand too late to receive the careful reading we should otherwise have liked to have given it. We hope to treat the succeeding volumes of the series in a more satisfactory manner.

Die Naturlichen Pflanzenfamilien. By A. Engler. Nos. 136, 137, 138, 139. (London: Williams and Norgate. Leipzig: Wilhelm Engelmann.)

These beautifully illustrated parts contain descriptions of the Pezizineæ (concluded), Phacidiineæ, and Hysteriineæ, by G. Lindau; Rhamnaceæ (concluded), by A. Weberbauer; Vitaceæ, by E. Glig; Meliaceæ (concluded), by H. Harms; Trigoniaceæ and Vochyiaceæ, by O. G. Peterson; Tremandraceæ and Polygalaceæ, by R. Chodat; and Dichapetalaceæ, by A. Engler.

In these parts there are 665 figures, comprised in 95 illustrations.

W. & A. K. JOHNSTONE'S BOTANY SHEETS FOR BEGINNERS, Nos. 1 and 2. (Edinburgh and London. 1896.) Price 3/6 each.

These are finely coloured sheets, mounted on canvas and rollers, suitable for Schools and Science Class Rooms.

Sheet I. treats of the Typical Root. Fig. 1 shows the Germination of an Acorn; 2, Matured Tap-Root System of Sunflower; 3, Annular Roots of Ipecacuanha; 4, Scabiosa, or Devil's Bit; 5, Garden Beet; 6, Carrot; 7, Yellow Turnip; 8, Snake-root; 9, Moniliform Roots of Pelargonium; 10, Drop-Wort; 11, A Diagrammatic View of a Tap-root with its Branches; 12, Apical portion of a Typical Root, as seen in Longitudinal Section; 13, Germination of Maize; 14, Fibrous Adventitious Roots of Meadow Grass; 15, Tuberous Adventitious Roots of Dahlia; 16, Orchis maculata; 17, Diagrammatic section of Tubers of same; 18, Simple Root of Lemna; 19, Ivy; 20 shows the parasitic (metamorphosed) root Mistletoe; 21, Rhizoids of Algæ; 22, Common Mushroom.

Sheet II. treats of Stems. Fig. 1 shows St. John's Wort; 2, Lesser Periwinkle; 3, Dutch Clover; 4, Strawberry; 5, House Leek; 6, 7, Mignonette; 8, Buds of Sycamore; 9, White Dead Nettle; 10, Daffodil; 11, Fox-tail; 12, Hop; 13, Convolvulus; 14, Vine; 15, 16, Furze; 17, Leaf-like Branches of Butcher's Broom; 18, Cactus; 25, Hop-stem, with parasitic roots of Dodder.

The explanatory text at the bottom of each chart is good.

HOW TO STUDY WILD FLOWERS. By Rev. Geo. Henslow, M.A., F.L.S., F.G.S., etc. For the Use of Schools and Private Students. Cr. 8vo, pp. 224. (London: Religious Tract Society. 1896.) Price 2/6.

This little book is intended to enable the student to rapidly acquire an *accurate* knowledge of typical British wild flowers, and to show him how he may attain this without other assistance. It is very plainly written and nicely illustrated with 47 engravings.

THE HISTORY OF MANKIND. By Prof. Friedrich Ratzel. Translated from the Second German Edition by A. J. Butler, M.A.; with Introduction by E. B. Tylor, D.C.L., F.R.S., etc. Vol. I. Royal 8vo, pp. xxiv.—486. (London: Macmillan and Co. 1896.) Price 12/- net.

This grand book offers those who are beginning anthropological work the indispensable outline sketches of the races of mankind, especially of the savage and barbaric peoples who display culture in its earlier stages, thus aiding the great modern nations to understand themselves. Besides a map, there are nine beautifully-coloured plates and a great number of illustrations.

A MANUAL OF NORTH AMERICAN BIRDS. By Robert Ridgeway. Illustrated by 464 outline drawings of the Generic Characters. Second edition, royal 8vo, pp. xiii.—653. (Philadelphia (U.S.A.): J. B. Lippincott Co. 1896.) Price 35/-

The first edition of this fine work appeared eight years ago. Since 1887 ninety-one species and sub-species have been added to the North-American fauna. A description of these has been added in the Appendix; whilst the whole work has been carefully revised and corrected. The drawings of chief generic characters, which are more or less in outline, cover 124 plates.

BRITISH BUTTERFLIES; being a Popular Handbook for Young Students and Collectors. By J. W. Tutt. Cr. 8vo, pp. 479. (London: George Gill and Sons. 1896.) Price 5/-

It is with much pleasure we notice this volume of "Hedgerow and Woodland" series. From it the young entomologist may learn the main facts relat-

ing to the variation, habits, and life-histories of some of our British Butterflies, and in which he will find an attempt to set clearly before him the structural peculiarities of their eggs, larvæ, pupæ, and imagines, those peculiarities which are now considered of importance by systematists being most fully dealt with.

The chapters on the Egg, Caterpillar, Chrysalis, and Imago will give the collector the clues he requires to follow up the more advanced branches of the study. The chapters on Collecting, Killing, Setting, and Preserving Insects will be found valuable, being based on Mr. Tutt's long practical experience.

There are 10 fine plates and 45 illustrations in the text. The book forms a nice companion volume to that on *British Moths*, noticed in our April part.

INSECTS AND SPIDERS: Their Structure, Life-Histories, and Habits. By J. W. Tutt, F.E.S. Cr. 8vo, pp. 116. (London: George Gill and Sons. 1896.) Price 1/-

This, which is Part II. of Gill's *Practical Series of Object Lesson Books*, describes the General External Characters, Internal Organs and their functions, and the Metamorphoses of Insects, with descriptions of the different orders of Insects, in a series of lessons which are meant to be merely suggestive, the point aimed at being to lead the child to observe. There are a number of good illustrations.

EARTH KNOWLEDGE: A Text-Book of Physiography. By W. J. Harrison, F.G.S., and H. R. Wakefield. Part I., 9th edition, and Part II., 6th edition. Cr. 8vo, pp. 266 and 240. (London: Blackie and Son. 1895.) Price 2/- each.

So considerable have been the changes and additions to these new editions that they are practically new books. Care has been taken to bring them up to date, and to embody the most recent discoveries in science, There are upwards of 220 illustrations in the two books, besides which both are accompanied by good indexes.

BY THE DEEP SEA: A Popular Introduction to the Wild Life of the British Shores. By Edward Step. F.L.S. Second edition. Cr. 8vo, pp. 322. (London: Jarrold and Son. 1896.) Price 5/-

To naturalists visiting the seashore we can recommend no more interesting book than the one before us. It treats of all those things likely to be met with—Low Life, Sponges, Zoophytes, Jelly Fishes, Sea Anemones, and the rest. It contains more than 120 illustrations, is written in a popular style, and cannot fail to interest every reader. Besides an Alphabetical Index, it contains that which we seldom find in popular works—a Classified Index of Species referred to. This we consider a very valuable addition, and one which authors of similar books would do well to follow.

THE BIOLOGICAL PROBLEM OF TO-DAY: Preformation or Epigenesis? The Bases of a Theory of Organic Development. By Prof. Dr. Oscar Hertwig; translated by P. Chalmers Mitchell, M.A. Cr. 8vo, pp. xx.—148. (London: William Heinemann. 1896.) Price 3/6.

This is an exceedingly interesting work, requiring very careful and attentive reading. It starts by asking the question, What is Development? Part I. treats of Weismann's theory of the Germ-plasm and Doctrine of Determinants; and Part II., Thoughts toward a Theory of the Development of Organisms.

LESSONS IN ORGANIC CHEMISTRY. Part I., Elementary. By G. S. Turpin, M.A. (Camb.), D.Sc. (Lond.). Crown 8vo, pp. vi.—140. (London: Macmillan and Co. 1894.) Price 2/6.

A series of lessons adapted to the Elementary Stage of the South Kensing-

ton Syllabus, commencing with the Analysis of Organic Bodies; Empirical and Molecular Formulæ; Hydrocarbons of the Methane Series, etc. etc. There are 33 illustrations.

A New English Dictionary on Historical Principles, founded mainly on the Materials collected by the Philological Society. Edited by Dr. James A. H. Murray, with the assistance of many Scholars and men of Science. (Oxford: The Clarendon Press. London: H. Frowde.)

The July part of this immense work commences with Diffluent and reaches to Disburden. This quarterly section contains 1,252 Main words, 153 Combinations explained under these, and 95 Subordinate entries—in all, 1,500 words. The *obvious combinations*, recorded and illustrated by quotations, without individual definition, number 150 more. Of the 1,252 main words, 942 are current and native or fully naturalised; the remainder are obsolete or alien, and are specially marked as such.

Algebra for Beginners. By William Dodds. New edition. 12mo, pp. 140 and 46. (London: Thos. Murby.) Price 1/4.

Various additions and improvements have been made in this new edition. In Stage I, "Negative and Fractional Values" have been added; in Stage II. the section on "Factors" has been re-written; and in Stage III. two new rules for the solution of "Equations of Two Unknowns" are added. The last 46 pages are occupied with the Answers.

Skertchly's Physical Geography. Revised to date by John H. Howell, B.A.Lond. Cr. 12mo, pp. viii.—224. (London: Thomas Murby. 1896.) Price 1/-

In this revised edition, many additions, corrections, and improvements have been made; the article on "Movements of the Land" has been entirely re-written. In the appendix, also, important additions have been made.

New Ground in Norway: Ringerike, Telemarken, Sæterdalen. By E. J. Goodman; with 56 illustrations from original photographs by Paul Lange. 8vo, pp. xvi.—224. (London: G. Newnes, Ltd. 1896). 10/6.

Relatively to the great army of British pleasure tourists who have flocked to the Western Fjords and the North Cape, but very few have explored the interior of Southern Norway, and for all but these that region is practically *terra incognito*, although it has long been to Norwegians as favourite a place of resort as the English and Scotch lakes are to Britons. The author describes his tour in a most pleasant and interesting manner. The illustrations are all first-class and the book is handsomely got up.

The Way about Devonshire. By H. S. Vaughan Cr. 8vo, pp. 256. (London: Iliffe and Son.) Price 1/-

This is a useful book for the tourist, conducting him in a series of twenty-four excursions from London to Exeter, and then by many pleasant routes Northwards, and by the coast to North Devon, then from Exeter into South-east Devon, and finally Southwards to Plymouth, Dartmoor, etc. There ls a capital map and some good illustrations.

The Romance of Industry and Invention. Selected by Robert Chambers. Cr. 8vo, pp. 295. (London and Edinburgh: W. and R. Chambers. 1896.)

A romantic interest belongs to the rise and progress of most of our industries; every fresh labourer in the field adds some link to the chain of progress,

and brings it nearer perfection. In this volume the author treats of Iron and Steel, Pottery and Porcelain, the Sewing Machine, Wool and Cotton, Gold and Diamonds, Big Guns, Small Arms and Ammunition, The Evolution of the Cycle, Steamers and Sailing Ships, Post Office, Telegraph, Telephone, and Phonograph. There are 34 good illustrations.

MODERN OPTICAL INSTRUMENTS and their Construction. By Henry Orford. Cr. 8vo, pp. vii.—101. (London: Whittaker and Co. 1896.) Price 2/6.

We consider the title of this book somewhat misleading, and are therefore disappointed with it, as it is almost exclusively confined to a description of the eye and spectacles. The author says his object "has been to place before the reader a descriptive outline of a few of what may be safely termed the more popular instruments in use. Taking the human eye as the most important, most instructive, and certainly the most valuable optical instrument known to science, its construction and properties are first of all dealt with."

INTENSITY COILS: How Made and How Used. By "Dyer." 17th edition. Cr. 8vo, pp. 79. (London: Perkin, Son, and Rayment.) 1/-

In addition to describing the construction and method of using Galvanic Batteries, Intensity Coils, etc., Electric Lighting, Electric Bells and Telegraph, Motors, the Telephone, Microphone, and Phonograph are all mentioned.

THE MAGIC LANTERN: Its Construction and Use. By a Fellow of the Chemical Society. Cr. 8vo, pp. 82. (London: Parker, Son, and Rayment.) Price 6d.

Those about to use the lantern during the coming winter will find information here likely to be useful.

PHOTOGRAPHIC ANNUAL for 1896: A Compendium of Information and Statistics for the Year. Edited by Henry Sturmey. 8vo, pp. 608 and clxviii. (London: Iliffe and Son.) Price 2/6; cloth, 3/6.

The present volume is a thoroughly up-to-date one, and one which must prove of great help to the photographer. The subject-matter is carefully arranged in sections, Sec. 1 being Tables of Reference and other useful information for Photographers, Photographic Dealers and Dark Rooms, Photographic Trade-marks of 1895; Sec. 2, Selected Articles on Practical Subjects by Practical Men; Sec. 3, Annals of Photography, being a Record of Progress in the several branches of the Science and Practice of Photography during 1895, including Photo-Chemistry, Photo-Optics, Photo-mechanical Printing, Photographic Art and Rontgen Rays, and Astronomical Photography; Sec. 4, The Photographic Societies of the United Kingdom; Sec. 5, The Latest Novelties in Photographic Apparatus and Materials, forming a continuation of the information contained in the Photographer's Indispensable Handbook and Photographer's Annuals, 1892-3-4, and 5; Sec. 6, The Latest Novelties in Optical Lanterns and Appliances relating thereto, forming a continuation of the Information contained in the Indispensable Handbook to the Optical Lantern and Photo Annuals for the years 1891-2-3-4, and 5; Sec. 7, Description to the Illustrations and Directories to the Photographic Trade. There are between 300 and 400 illustrations in the text, and a number of beautifully executed photo-mechanical full-page plates. We think the volume far in advance of any of its predecessors.

THE ABC OF MODERN (DRY-PLATE) PHOTOGRAPHY. Cr. 8vo, pp. viii.—193. (London: The Stereoscopic and Photographic Co., Ltd.)

The first portion of this little book is written, as its title implies, for those who know practically nothing about Photography. The second part will be found somewhat more advanced; whilst the remainder is devoted to formulæ and general hints. It is a useful little book.

DROP-SHUTTER PHOTOGRAPHY. By Fred W. Pilditch. pp. 64 size $7\frac{1}{2}$ by 4 inches. (London: Percy Lund and Co. 1896.) Price 6d.

This is No. 1 of Percy Lund's Popular Photographic Series. The peculiar shape of the book makes it very convenient for the pocket. It is profusely illustrated with views, etc., and contains many useful hints.

THE ELEMENTS OF STEREOSCOPIC PHOTOGRAPHY. By C. F. Seymour Rothwell, F.C.S. $7\frac{1}{2}$ by 4 in., pp. 56. (Bradford and London: Percy Lund and Co. 1896.) Price 6d. net.

This is another of the Popular Photographic Series, in which the details of the practice is given in a simple and concise manner. The book is printed on good paper and nicely illustrated.

THE JUNIOR PHOTOGRAPHER, Summer Double No., Aug., 1896.

THE PRACTICAL PHOTOGRAPHER, Sept. Double No., entitled Photography and Photographers,—This is a Japanese number, and is fitted with a number of very beautiful pictures from Japan.

These Journals are published by Percy Lund and Co., Ltd., London, and, like all Mr. Lund's publications which we have yet seen, are very beautifully illustrated.

BEGINNER'S GUIDE TO PHOTOGRAPHY, showing how to Buy a Camera and how to Use it. By a Fellow of the Chemical Society. Cr. 8vo, pp. 119. (London: Perkins, Son, and Rayment.) Price 6d.

We have here practical remarks on Photographic Apparatus generally; How to take a Photograph; Development; Printing from the Negative; Taking Instantaneous Pictures; Producing Lantern Slides; Photo-Micrography and Enlarging.

THE CAT: Her Place in Society and Treatment. By Edith Carrington. Cr. 8vo, pp. 79. (London: G. Bell and Sons. 1896.) 1/-

Those who like to see a cat in the house—and there are few who do not—will be interested in reading about Her Personality; Do Cats Think?; How Pussy can love; Comradeship in Cats; Puss as a Professional; Food and Housing; When Puss is ill; Paterfamilias and Materfamilias; and Waifs and Strays, as told in this little book.

JOHN PLOUGHMAN'S PICTURES; or, More of his Plain Talk for Plain People. By C. H. Spurgeon. Cr. 8vo, pp. 160. (London: Passmore and Alabaster. 1896.) Price 1/-

All are acquainted with the trite sayings of the late Mr. Spurgeon's *John Ploughman*. Those we meet with in the book before us are by no means behind those of *John Ploughman's Talk*.

We are informed that the publishers of Mr. Spurgeon's sermons have just received an order for *one million copies* from the Brighton Memorial Society for the distribution of the sermons as loan tracts.

THE ROYAL NATURAL HISTORY, Part 34. Edited by Richard Lydekker, B.A., F.R.S., etc. (London: F. Warne and Co.) Price 1/-

In the present part is commenced a description of Sub-Kingdom ECHINODERMATA, which includes the Stone-Lilies, Star-Fishes, Sea-Urchins, and Sea-Cucumbers; followed by the MOLLUSCA, of which the classes *Cephalopoda* and *Gastropoda* are described. The anatomy and development of these creatures are fully described. There are two fine coloured plates and a great number of good illustrations.

THE ORACLE ENCYCLOPÆDIA, containing the most accurate information in the most readable form. Part 26. (London: Geo. Newnes, Ltd.) Price 6d. net.

This part commences with RUSSIAN LANGUAGE AND LITERATURE, of which a fairly lengthy account is given, and ends with SHAWL. Many of the articles are illustrated.

WORK: The Illustrated Weekly Journal for Mechanics. Vol. XI., Jan. to July, 1896. Folio, pp. 416. (London: Cassell and Co.)

A glance at the index of this volume, which occupies nearly 8 pages, each of four columns, shows that it is a journal which perfectly answers to the name it bears. Instructions will be found in it for making and repairing practically everything from an American Organ to a Zither.

THE BOOK OF THE FAIR. Parts 22, 23, 24, 25. (Chicago, Ill., U.S.A.: The Bancroft Co.) Price $1 each part.

This grand work was concluded a few months ago, but by an oversight we omitted to notice it in our last. As a specimen of the printer's art we have seen nothing to equal this work, which consists of 1,000 12 by 16¼ in. pages, It is printed throughout on fine plate paper, and each page contains one or several very fine photo-mechanical engravings.

We think the next best thing to having actually seen the great Columbian Exhibition is to possess a copy of this very fine work, which, to use the author's words, " confines itself neither to art alone on the one side. nor to dry statistics on the other, but aims to present, in attractive and accurate form, the whole realm of art, industry, science, and learning, as here exhibited by the nations." It contains over 2,000 illustrations.

GOLDEN THOUGHTS from the Book of Spiritual Poverty, and GOLDEN THOUGHTS on The Higher Life. By Dr. Johann Tauler (1300 to 1361). Translated by M.A.C.; with Introductory Notice by T. M. Lindsay, D.D. Crown 8vo, pp. 120 and 128. (Glasgow: David Bryce and Son.) Price 2/- each.

The two little books before us are translated from the writings of a theologian of the early part of the 14th century, and are, as will be judged from the titles, of a purely religious character. They are very neatly got up.

The last numbers to hand of Messrs. Cassell's serials are:—

BATTLES OF THE NINETEENTH CENTURY, No. 19. Price 7d.

This contains the conclusion of the Battle of Gravelotte; The first Burmese War; The end of the Nile Campaign; The Belgian War of Independence, Brussels; The Janissary Rebellion at Widdin; Bergen-op-Zoom; The Bombardment of Alexandria (commenced). There is a full-page Frontispiece and many illustrations.

CASSELL'S CONCISE CYCLOPÆDIA, Part 6. Price 6d.

This part commences with the word HUNDREDWEIGHT and concludes with MACEDONIA. The frontispiece is a full-page illustration of the Tower of London. There are several other illustrations.

CASSELL'S NATURAL HISTORY, Parts 14 and 15. Price 6d.

These numbers contain descriptions of the *Passeriformes*, or Perching Birds; *Columbæ*, the Doves; *Gallinæ*, the Game Birds; *Grallæ*, the Wading Birds; *Herodiones*, the Herons; and the Geese, *Anseres*. Each number contains several plates and many other good illustrations.

THE STORY OF THE HEAVENS, Part 12. Price 6d.

Contains the conclusion of Chapter 17 on Shooting Stars, Chapter 18 on the Starry Heavens, and the commencement of Chapter 19 on Distant Suns. The frontispiece to this part shows Coggia's Comet as seen on June 10th and July 9th, 1874.

EUROPEAN BUTTERFLIES AND MOTHS, Part 28. Price 6d.

Like all its predecessors, this part contains a beautiful plate, showing several moths, with their larvæ, pupæ, and eggs.

CHUMS. Price 6d.

In the September part the two somewhat exciting serial stories are concluded. Besides two continued tales, each part contains a number of shorter ones, which cannot fail to interest the boys.

SCIENCE FOR ALL. Edited by Robert Brown, M.A., Ph.D., F.L.S., F.R.G.S., etc. Part 9. Price 6d.

This part commences the third volume, and contains well illustrated papers on the following subjects:—Corals and their Polypes; Burnt-out Volcanoes; Celestial Objects viewed with the Naked Eye; The Colour of the Sea; Flowering; Why the Clouds Float and What the Clouds Say; Hairs and Scales; An Old Continent in the Atlantic Ocean; The Electric Light; A Soap Bubble; A Butterfly; A Piece of Whinstone; The Bottom of the Sea; Mars; and Visible Sound.

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END OF VOLUME VI.